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The
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EDITORIAL

Paddy Research in Ceylon

PADDY research in Ceylon may be said to date back to the days of the Ceylon Agricultural Society which was responsible for simple investigations on the response of the crop to manures, transplanting, seed rates, soil conditions in relation to yield, and the pests and diseases of the crop and their control. New varieties of paddy were also introduced from time to time, but little systematic work was done on the selection of high-yielding strains. Though attempts to improve the *hatiel* variety of paddy grown in the Kandy district were made by R. H. Lock (1902–1904), systematic investigations on paddy selection only began with the appointment of F. Summers as Economic Botanist in 1920 when work on the isolation of high-yielding strains was initiated with long-term varieties at Peradeniya and short-term varieties at Anuradhapura. R. O. Iliffe succeeded Summers a year later and was successful in selecting at least one pureline, viz : B 11 (*Kohumawi*) which continues to be to this day a popular six months' paddy in the district. Iliffe was alive to the need for eliminating soil heterogeneity in his trials and conducted pioneer investigations on what he termed " soil error ". It was not, however, till L. Lord filled the post of Economic Botanist in 1926 that selection work with paddy was placed on a satisfactory statistical basis. He adopted the methods of field experimentation advocated by R. A. Fisher and secured results which were strikingly fruitful. He established a number of paddy stations all over the Island and was successful in evolving several purelines, for example, Vellai Illankalayan, Pachchaiperumal, Podiwi *a*8. Lord's interest extended to cultural and manurial trials as well. He confirmed the superiority of transplanting to broadcasting and obtained data of considerable value on the manurial requirements of the crop. Nitrogen and/or phosporic acid were proved to be its dominant nutritional needs in many parts of the Island. Lord was also responsible for the introduction of the wooden tooth harrow into the Island. Further studies on the manurial and cutural requirements of the crop were undertaken by J. C. Haigh and A. W. R. Joachim. The former also conducted certain fundamental studies on the agronomy of the crop.

A new development occurred in 1937 with the creation of a separate Paddy Division with G. V. Wickremasekera as Paddy Officer. Trials on selection, cultivation methods and manuring were continued and the practice of harrowing the standing crop introduced. This has proved advantageous where transplanting, for one reason or another, is not feasible. Wickremasekera imported a number of varieties of salt-resistant paddies and tested them out at various centres in the coastal belt. Among these was *pokkali*, which has become popular in some areas.

In 1946, as a result of a reorganization scheme whereby six agronomic divisions based on agro-climatic zones were created, each in the charge of an Agricultural Research Officer to undertake the research problems relating to the major crops of the Division, the Paddy Division was abolished. The planning, cordination and the general direction of the research programme in these divisions was delegated to the Botanist and Senior Agricultural Research Officer. Paddy, being the most important crop in all the Divisions, thus received a good deal of more localised attention than was possible previously.

Among the important lines of research which have engaged the attention of these Agricultural Research Officers, mention should be made of the following :—the intensification of breeding work on the crop and the testing out of hundreds of introduced and indigenous rices; an extensive programme of hybridisation with the objects, among others, of eliminating the defects in Ceylon purelines and developing strains which combine salt and flood resistance; the study of photoperiodism in rice; the response of the crop to nitrogenous and phosphatic fertilizers ; the effect of pre-treatment of paddy on yield, drought endurance, &c. These trials have been conducted in various parts of the Island, but special reference should be made to the Bathalagoda Rice Research Station where intensive work on the crop is being undertaken. In this number of *The Tropical Agriculturist*, Chandraratne, Abeyratne and Ariyanayagam furnish the results of some of their recent investigations on aspects of research referred to above. These findings deserve the close study of everyone interested in fundamental paddy research. They also furnish information of practical value to the paddy cultivator and to our extension officers, viz., the risks of crop failures by the use of varieties which are too sensitive to photoperiodic influences, and the benefits of the simple pre-sowing treatment of the repeated soaking in water and drying of seed.

Marked advances have also been made with the control of pests and diseases of the crop. The insecticides D. D. T. and gammexane have been proved to be very efficacious, notably in the control of paddy-fly and leaf swarming caterpillar. The use of organo-mercuric chemicals in the control of certain seed-borne diseases of paddy like foot rot (*Fusarium moniliforme*) has also been established by the Pathological Division.

Another sphere in which advances have been made is in regard to the preparatory tillage of the land and simple implements for its execution. Following on the demonstration of the marked superiority of the mouldboard over the village plough, the Department has designed two types of light iron ploughs, designated models C and D, suited for medium and light soils respectively.

Paddy research will continue to receive the closest attention of the Department and the prospects of valuable findings are distinctly promising. Pilot crop yield surveys carried out by the Botanist on the basis of random crop cuttings have indicated that the results of our research and extension activities have begun to bear fruit. These surveys revealed that the average crop yield varies from 27 bushels to 42 bushels per acre per season in the districts in which they were carried out. An all-island survey planned and directed by the Statistician appointed by F. A. O., now under way, will afford confirmation or otherwise of these results. It is hoped that in the years to come the benefits of research and extension will be even more marked than they have been in the past.

ORIGINAL ARTICLES

Photoperiod Effects on the Flowering of Tropical Rices

BY

M. F. CHANDRARATNA

1.—INTRODUCTION

RICE, in common with most tropical species, is a short-day plant. The occasional occurrence of long-day forms has, however, been claimed. Moreover, marked differences in varietal sensitivity exist; the recognition of period- and date-fixed forms is based on these differences. The investigation reported herein aimed at providing information on the range of photoperiod sensitivity in rices native to Ceylon and to some of the other tropical countries. Such information is not merely of academic interest in this country where the growing of sensitive varieties is possible only in the *maha* (North-East monsoon) season, and where, even in *maha*, shortage of water often compels a *meda* cultivation for which only period-fixed forms can be used. Whatever be the evolutionary significance of photoperiod sensitivity in the tropics, there is little doubt that elimination of sensitivity is a desired breeding objective.

It was realized that a complete understanding of the nature of varietal differences in sensitivity was not possible unless the form of the curve relating the photoperiod to the seeding-to-flowering interval was known. Indeed, the characterisation of photoperiod reaction by means of response curves appeared to be an essential preliminary to satisfactory genetic analysis. An attempt has been made in this contribution to define sensitivity and related concepts in terms of response curves.

2.—REVIEW OF LITERATURE

Most of the reported investigations of photoperiodism in rice have been conducted in sub-tropical and temperate areas, and concern *japonica* forms native to those latitudes. Japanese workers (Yoshi, 1926, Kondo *et al.*, 1933 and 1934, Tabata *et al.*, 1934, and Miyashiro, 1935) have noted an acceleration of the flowering of *japonicas* ranging from one week to eight weeks, when the day length is reduced to 8–12 hours.

Beachell (1943) in Texas, U. S. A., subjected ten varieties, including both *japonicas*, *indicas* and forms presumably derived from hybrids between them, to 10-hour photoperiods, for durations of 10–30 days, at different stages

of growth. In all instances, subjection to short day hastened heading, but varieties varied in sensitivity. Forms indigenous to latitudes above 30° N were more sensitive than those from areas nearer the Equator. Apart from a marked shortening in age, the sensitive varieties exhibited, under short day, a decrease in tiller number, in ear number and length, in plant height and in grain and straw yields.

In India, two groups of varieties are recognized, viz., summer varieties whose flowering is promoted by photoperiods exceeding 12 hours, and winter varieties which flower at day lengths less than 12 hours. Kar and Adhikary (1945) noted a reduction in the age of winter varieties when subjected to short day. By the use of short photoperiods, Sircar and Parija (1945) achieved a reduction in the age of the winter variety, *Rupsail*, from 133 days to 47.

The photoperiod reaction of tropical rices has not been the subject of extensive study. Scripchinsky (1940) suggested that the failure of late varieties in Ceylon to flower in the *yala* (South-West monsoon) season was due to their high degree of sensitivity to the photoperiod. Chandraratna (1948) proved the correctness of Scripchinsky's surmise. The maximum daylength difference in Ceylon is less than an hour, but this difference decides the flowering of late varieties. Chandraratna induced the flowering of late varieties sown in *yala* by the use of short day; *Kohumawi*—B. 11 under normal day failed to flower in eleven months, but under a 9-hour photoperiod flowering occurred in two months. Murray (1950) working in a comparable latitude confirmed Chandraratna's findings, and showed that Trinidad rices behaved like the late varieties of Ceylon.

3.—EXPERIMENTAL MATERIAL

The experimental material consisted of twelve Ceylon, five Indian, seven Indonesian and two Burmese varieties. Brief descriptions of these varieties are given in Table 1. All the varieties except the Indonesian gundils belong to the *indica* group. The variety *Heenati* warrants particular mention. It belongs to the group recorded by Abeyratne (1952) and believed by him to be long-day plants. The variety *Devaredderi* is also of interest in that it is one of the rare period-fixed, late varieties indigenous to Ceylon.

TABLE 1.—List of Varieties Tested

	Country of Origin	*Name of Variety and if a Pureline, its Index No.*	*Flowering duration* in Months*	*Reaction to Natural Day Length*	*Remarks*
1.	Ceylon	.. Panduruwi	.. 5½ in *maha*	Date-fixed	A profusely tillering variety from the Central Province
2.	Do.	.. Kohumawi–B. 11	.. 5 do.	.. do.	.. A Central Province pureline
3.	Do.	.. Devaredderi–26081	.. 4–4½	.. Period-fixed	A flood-resistant pureline from the Province of Sabaragamuwa
4.	Do.	.. Pachchaiperumal–2462/11	2	.. do.	.. Grown extensively in the dry zone in *yala*

* The flowering duration is the interval from seeding to flowering.

	Country of Origin	Name of Variety and if a Pureline, its Index No.	Flowering duration* in Months	Reaction to Natural Day Length	Remarks
5.	Ceylon	Vellai Hankalayan–28061	3	Period fixed	The most popular pureline in Ceylon; possesses great adaptability
6.	Do.	Sinnanayan–2208	2	do.	A Southern Province pureline
7.	Do.	Heenati	2	do.	A North-Central Province variety with serrate sterile glumes and transverse pedicel attachment—(Abeyratne, 1952)
8.	Do.	Halsuduwi	2	do.	From the North-Central Province
9.	Do.	Murunga	2	do.	do.
10.	Do.	Kegalle Type 1	3	do.	From the Province of Sabaragamuwa
11.	Do.	Kegalle Type 2	3	do.	do.
12.	Do.	Kegalle Type 3	3	do.	do.
13.	Indonesia	Brondol putih–277	4	do.	A *gundil*** pureline (Van der Meulen 1941)
14.	Do.	Gendjah-beton–1101	4	do.	do.
15.	Do.	Peta–2802	3	do.	Derived from a cross between *Tjina* and *Lati Sail* (Van der Meulen, 1941)
16.	Do.	Salak–2885	4	do.	do.
17.	Do.	Mas–2401	4	do.	A *Tjereh* pure line (Van der Meulen, 1941)
18.	Do.	Major	4	do.	do.
19.	Do.	Pulut Nangka–016	3	do.	An upland pureline
20.	Burma	—MYAC–104	2½ in *maha*	Date-fixed	From Myaungmya; grain Class C in Beale's classification
21.	Do.	—HMC–20	3 „	do.	From Hmawbi; grain Class C in Beale's classification
22.	India, United Provinces	—N–22	2	do.	—
23.	Do.	—N–27	2	do.	—
24.	Do.	—A 64	2	do.	—
25.	India, Bombay	—K –540	3	do.	—
26.	India, Travancore	Pokkali	3	do.	Salt-resistant

4.—VARIETAL TESTS FOR REACTION TO THE PHOTOPERIOD

The varieties *Panduruwi*, *Kohumawi* and *Devaredderi* were tested in *maha* 1949. The performance of the others was investigated in *yala* 1951. Sprouted seed was dibbled in paddy soil in cement pots with a sowing surface measuring one foot square. Plants were thinned progressively from the seventh day after seeding to the twenty-first; an ultimate stand of 30 plants per pot was ensured. Short-day treatment commenced on the twenty-first day after seeding and continued till emergence. Treated pots were moved out of the dark room into the open at 6 a.m. and reverted to the dark at 3 p.m.; the period of insolation was accordingly nine hours. Control pots exposed to natural day were maintained. The interval between dibbling of seed and the emergence of the tip of the panicle above the flag leaf was recorded in the instance of every plant. The mean intervals for the varieties under natural and short day are presented in Table 2.

---

* The flowering duration is the interval from seeding to flowering.

** A *gundil* may be defined as an unbearded *bulu*. *Bulus* are claimed to be *japonicas*, and the *tjerehs*, *indicas*

TABLE 2.—Reaction of Ceylon, Indian, Indonesian and Burmese Varieties to a Nine-Hour Photoperiod

Sowing Date	*Variety*	*Interval in Days from Seeding to Heading*					
		Under Natural Day		*Under 9-Hour Photoperiod*		*Difference*	
		Mean	*Standard error*	*Mean*	*Standard error*	*Mean*	*Standard error*
August 4, 1949	Panduruwi ..	> 145 ..	— ..	70 ..	— ..	> 75 ..	—
Do.	.. Kohumawi–B. 11 .	> 145 ..	— ..	68 ..	— ..	> 77 ..	—
Do.	.. Devaredderi–26081	106 ..	± 0·48 ..	72 ..	± 0·41 ..	+ 34 ..	± 0·62*
May 2, 1951	.. Pachchaiperumal–2462/11	69 ..	± 0·82 ..	59 ..	± 0·35 ..	+ 10 ..	± 0·89*
Do.	.. Vellai Ilankalayan–28061	99 ..	± 0.40 ..	79 ..	± 0·57 ..	+ 20 ..	± 0·70*
Do.	.. Sinnanayan–2208 .	97 ..	± 0·44 ..	74 ..	± 0·37 ..	+ 23 ..	± 0·57*
Do.	.. Heenati ..	69 ..	± 0·28 ..	73 ..	± 0·49 ..	— 4 ..	± 0·57*
Do.	.. Halsuduwi ..	81 ..	± 0·19 ..	56 ..	± 0·30 ..	+ 25 ..	± 0·67*
Do.	.. Murunga ..	72 ..	± 0·87 ..	54 ..	± 0·24 ..	+ 18 ..	± 0·90*
Do.	.. Kegalle Type 1 ..	99 ..	± 0·36 ..	63 ..	± 0·42 ..	+ 36 ..	± 0·56*
Do.	.. Kegalle Type 4 ..	117 ..	± 1·55 ..	58 ..	± 0·33 ..	+ 59 ..	± 1·59*
Do.	.. Kegalle Type 20 .	98 ..	± 0·55 ..	62 ..	± 0·44 ..	+ 36 ..	± 0·70*
Do.	.. Brondol putih–277	143 ..	± 1·22 ..	140 ..	± 1·03 ..	+ 3 ..	± 1·60*
Do.	.. Gendjah beton–1101	124 ..	± 1·05 ..	116 ..	± 0·52 ..	+ 8 ..	± 1·17*
Do.	.. Peta–2808 ..	129 ..	± 1·35 ..	90 ..	± 1·08 ..	+ 39 ..	± 1·73*
Do.	.. Salak–2885 ..	123 ..	± 0·55 ..	91 ..	± 1·20 ..	+ 32 ..	± 1·32*
Do.	.. Mas–2401 ..	114 ..	± 0·64 ..	80 ..	± 0·65 ..	+ 34 ..	± 0·91*
Do.	.. Major ..	126 ..	± 0·83 ..	124 ..	± 0·86 ..	+ 2 ..	± 1·20
Do.	.. Pulut nangka–016	131 ..	± 0·47 ..	92 ..	± 0·99 ..	39 ..	± 1·10*
Do.	.. —MYAC 104 ..	161 ..	± 1·93 ..	53 ..	± 0·11 ..	+ 108 ..	± 1·93*
Do.	.. —HMC–20 ..	164 ..	± 2·01 ..	62 ..	± 0·76 ..	+ 102 ..	± 2·15*
Do.	.. —N–22 ..	58 ..	± 0·34 ..	57 ..	± 0·37 ..	+ 1 ..	± 0·50
Do.	.. —N–27 ..	63 ..	± 0·44 ..	62 ..	± 0·54 ..	+ 1 ..	± 0·69
Do.	.. —A–64 ..	52 ..	± 0·75 ..	54 ..	± 0·22 ..	— 2 ..	± 0·79
Do.	.. —K–540 ..	83 ..	± 0·38 ..	69 ..	± 0·50 ..	+ 14 ..	± 0·63*
Do.	.. Pokkali ..	110 ..	± 0·33 ..	62 ..	± 0·77 ..	+ 48 ..	± 0·84*

The most interesting result of the 1949 test is the demonstration of a high degree of sensitivity in the period-fixed pure line *Devaredderi* 26081 ; the mean reduction in age consequent on subjection to short day was 34 days. Both *Kohumawi* and *Panduruwi* exhibited the anticipated sensitivity.

Tests in *yala* 1951 revealed appreciable sensitivity in all the early Ceylon varieties which had hitherto not been suspected of possessing any degree of sensitivity ; *Halsuduwi* for instance, shortened its age under the 9-hour photoperiod, by 25 days. *Heenati* headed slightly but significantly later under short day ; the result confirm the findings of Abeyratne (1952).

The Burmese pure-lines MYAC 104 and HMC 20 were the most sensitive of the early** strains, and reduced their heading time by 108 days and 102 days respectively under the 9-hour photoperiod. The Indian strains, N 22, N 27 and A 64 were the least sensitive of the early varieties investigated.

The Indonesian varieties fall into two sharply-defined classes, viz., the sensitive *tjereh* group represented by *Peta*, *Salak*, *Mas* and *Pulutnangka*,

* Significant at the 5 per cent. point.

** MYAC 104 and HMC 20 have flowering durations of 2½ and 3 months respectively in *Maha*.

and the insensitive *bulus* like *Brondol putih*, *Gendjah beton* and *Major*. Short day hastened the heading of the *tjerehs* by 32–39 days. On the other hand, age reduction in none of the *bulu* varieties exceeded eight days. The *bulus* are unique among tropical rices. In no tropical country does there appear to be a group of late varieties with the degree of insensitivity that the *bulus* possess.

5.—CURVES RELATING THE PHOTOPERIOD TO THE SEEDING-TO-HEADING INTERVAL

The effect of the photoperiod on the heading time of the five varieties, *Heenati*, *Vellai Ilankalayan* 28061, *Kohumawi* B-11, *Panduruwi* and MYAC 104 was the subject of detailed study in *maha* 1951–52. The methods employed were identical with those used previously except that in the instance of *Heenati*, *Vellai Ilankalayan* and *Kohumawi*, two-leaf seedlings were transplanted into pots. In the instance of *Heenati*, photoperiods exceeding 12 hours were secured by the use of an electric lamp which provided the treated plants with an illumination intensity of three foot-candles. Careful temperature control was attempted. The results are presented in Table 3.

TABLE 3.—Effect of the Photoperiod on the Seeding-to-Heading Interval

Photoperiod	*Mean Interval in Days from Seeding to Heading*				
	Heenati	*Vellai Ilankalayan 28061*	*Devaredderi 26081*	*Kohumawi B 11*	*MYAC 104*
6 hours 0 minutes	91·2	102·2	—	95·7	104·2
6 „ 30 „	81·8	100·0	101·9	90·4	95·9
7 „ 0 „	74·1	96·6	99·0	82·2	87·8
7 „ 30 „	74·1	87·0	87·2	87·7	78·4
8 „ 0 „	73·1	87·0	92·4	79·4	86·8
8 „ 30 „	72·8	85·9	84·3	79·9	83·8
9 „ 0 „	71·5	87·6	93·4	78·2	78·6
9 „ 30 „	71·7	86·1	78·7	76·9	70·7
10 „ 0 „	70·0	84·6	74·0	77·1	69·2
10 „ 30 „	68·5	86·6	72·7	76·3	67·0
11 „ 0 „	69·8	88·3	73·1	77·2	67·0
11 „ 30 „	68·0	90·8	75·7	84·5	69·0
12 „ 0 „	68·0	100·6	79·8	110·6	80·1
12 „ 30 „	67·6	—	—	—	—
13 „ 0 „	71·4	—	—	—	—
13 „ 30 „	72·4	—	—	—	—
14 „ 0 „	78·4	—	—	—	—
14 „ 30 „	79·3	—	—	—	—
15 „ 0 „	91·0	—	—	—	—
15 „ 30 „	105·5	—	—	—	—
16 „ 0 „	114·5	—	—	—	—

6.—DISCUSSION

The concepts of age and sensitivity derived from the curve relating the photoperiod to the seeding-to-flowering interval may be outlined at this stage. The *minimum flowering duration* of a variety is defined as the shortest possible seeding-to-flowering interval.

For instance, Fig. 1 indicates that the minimum flowering durations of *Vellai Ilankalayan* 28061, *Kohumawi* B-11 and MYAC 104 are 85, 76 and

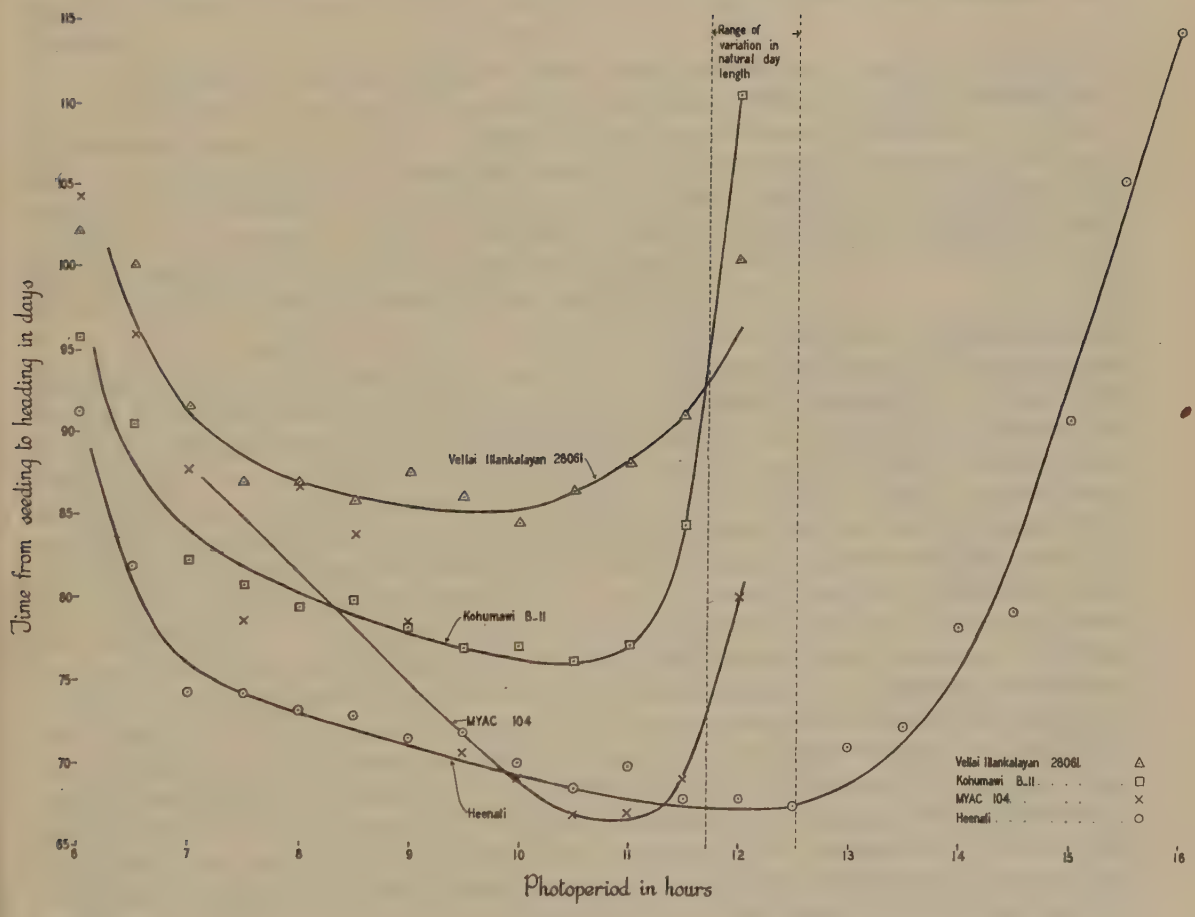

Fig. I. Curves relating photoperiod to seeding-to-heading interval

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of *Vellai Ilankalayan* 28061, *Kohumawi* B-11 and MTAC 104 are 85, 76 and

67 days respectively. The photoperiod corresponding to the minimum flowering duration is referred to as the *optimum photoperiod.* It is seen in Fig. 1 that *Heenati* has an optimum in the neighbourhood of $11\frac{1}{2}$–$12\frac{1}{2}$ hours, and that for all the other varieties tested, the optimum lies in the region of 10–11 hours. The possession of an optimum at $11\frac{1}{2}$–$12\frac{1}{2}$ hours explains why the variety *Heenati* extends its age when given a 9-hour photoperiod ; the long days of over 12 hours that obtain in *yala* in Ceylon are optimal for *Heenati.*

The gradient of the response curve may be used as a measure of sensitivity. It should be noted in this connection that all the curves are asymmetric, and that there appears to be no constant gradient on either side of the optimum. These estimates of minimum flowering duration, optimum photoperiod and sensitivity adequately describe the photoperiod reaction of a variety. It is, of course, realized that the photoperiod interacts markedly with other factors, particularly temperature. A discussion of these interactions is, however, not attempted here.

Ceylon varieties are not as numerous as the multiplicity of local names suggests. The total number of varieties is, nevertheless, large. None of the Ceylon varieties tested have proved to be completely insensitive. Even the varieties usually regarded as period-fixed exhibit an appreciable degree of sensitivity. As a rule the early varieties indigenous to this country are strikingly less sensitive than the late varieties. Relatively insensitive varieties with a flowering duration not exceeding three months are characteristic of Ceylon, and are rare in most tropical countries. Two varieties not included in the tests reported herein, viz., the Southern Province *Balamawi* and the North-Central Province *Suduwi* are exceptional in this class in their possession of high sensitivity and in their failure to flower in *yala.* Ceylon varieties with a flowering duration of over four months are extremely sensitive, and if sown in *yala,* remain vegetative till the short days of *maha* supervene. The behaviour of *Devaredderi* is exceptional ; it is a late variety but is sufficiently insensitive to permit its being grown in *yala.* It should be noted that late varieties like *Kohumawi* B-11 and *Panduruwi* have minimum flowering durations not appreciably longer than those of the earliest of the Ceylon varieties. Indeed one may state broadly that Ceylon varieties differ not so much in the minimum flowering duration as in the sensitivity to the photoperiod.

In striking contrast to the late Ceylon varieties, the *bulu* varieties of Indonesia possess uniformly low sensitivity and may be presumed to possess longer minimum flowering durations.

Only two Burmese varieties have been tested. The seeding-to-flowering interval of neither exceeds three months in *maha,* but unlike most Ceylon varieties in this class, they have proved highly sensitive. The behaviour of MYAC 104 and HMC 20 resembles that of *Balamawi.*

The Indian varieties tested showed low sensitivity, but the range was limited and unrepresentative and did not permit a generalization on the behaviour of varieties native to that country.

Curves relating the photoperiod to the flowering duration have been constructed only for five varieties. The chief value of these response curves is that they permit the precise description of the performance of varieties in terms of minimum flowering duration, optimum photoperiod and sensitivity. In the instance of the variety *Heenati*, the curve has served the further purpose of elucidating the curious behaviour noted by Abeyratne (1952).

7.—SUMMARY

Twenty-six varieties of rice including twelve from Ceylon, seven from Indonesia, five from India and two from Burma, were tested in the years 1949 and 1951, for photoperiod reaction by subjection to a 9-hour day. Heading of all varieties, except *Heenati* from Ceylon and A-64 from Bombay, was hastened by the short-day treatment.

Devaredderi 26081 and the early varieties from Ceylon which had been known to be period-fixed exhibited an appreciable and hitherto unsuspected degree of sensitivity.

Curves relating the photoperiod to the seeding-to-heading interval were constructed for five of the varieties. Concepts of sensitivity, minimum flowering duration and optimum photoperiod based on these response curves are defined. The use of these estimates in characterizing the photoperiod reaction of varieties is explained.

Most of the varieties tested have an optimum photoperiod of 10–11 hours. The apparent long-day reaction of *Heenati* is explained by its possession of an optimum at $11\frac{1}{2}$–$12\frac{1}{2}$ hours.

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Preliminary Studies on the Pre-sowing Treatment of Paddy

BY

D. V. ARIYANAYAGAM

INTRODUCTION

EXPERIMENTS on pre-sowing treatment of seed paddy as a means of inducing drought resistance were commenced in the Batticaloa District as a result of some difficulty experienced in obtaining irrigation water during the early stages of growth of the *maha* crop. Water from the minor tanks in the District is not available to the paddy crop till January. The preparation of the land and sowing are, therefore, done with the help of the rains in October or November ; and the crop is entirely rain-fed in the early stages. In the event of a drought setting in after the paddy is sown with the help of the initial showers, the crop runs the risk of total or partial failure. It was, therefore, useful to find out whether the pre-sowing hardening treatment of seed paddy would help the seedlings to tide over this critical period.

Experiments carried out in other parts of the world—chiefly Russia and India—on wheat and other crops, have shown that repeated soaking of the seed in water and drying it before sowing induced a certain degree of drought resistance to the crop. HENKEL (1) reported that pre-sowing hardening (attained by repeated soaking of seed to 20–30 per cent. moisture and drying) increased the resistance of subsequent plants to atmospheric and soil dryness. HENKEL and KOLOTOVA (2) have shown that triple soaking and drying of seed induced a more xeromorphic structure, increased osmotic pressure, intensified metabolism and, what was thought to be particularly important, induced greater hydrophily of protoplasmic colloids. ISIP (3) found that the best results were obtained when the seeds soaked for 6 hours were kept in the air for 24 hours and then air-dried. This treatment on wheat, barley, millets, sunflower and beets resulted in early germination (4 to 5 days earlier than control), higher percentage of germination and increased yields. CHINOY (4) working with Indian wheats, has shown by means of pot and field experiments that plants grown from pre-hardened seed reached anthesis earlier than those grown from untreated seed. The only reference the writer came across to this type of work on paddy was that of PARIJA (5). His treatment consisted of soaking the seed in water for 24 hours, air-drying for 6-8 hours, followed by heating the seed at 40–42°C. for 24 hours. He reported that the treated plants flowered 8–10 days earlier, their water requirement was less, yield was greater, and the dry weight of the tops was more.

The investigations described in this paper were commenced in *Maha* 1949/50 at Karadiyan Aru Farm and later continued at Karadiyan Aru and Unnichchai Farms, in order to ascertain :

(*a*) whether drought resistance could be induced to the paddy crop under local conditions by means of the pre-sowing hardening treatment ;

(*b*) whether increased yields could be obtained under local conditions by means of this treatment ;

(*c*) whether different varieties of paddy required different treatments ; and

(*d*) if so, the pre-sowing treatment which would give the best results for each variety.

METHODS

Reference to the literature on this subject indicates that the pre-sowing hardening treatment consists of 4 operations, which described in sequence are :

(1) soaking the seed in water for a certain period ;
(2) keeping the seed in air in a wet condition for a certain period ;
(3) drying the seed in air under shade for a certain period ; and
(4) heating the seed at a temperature slightly higher than air-temperature for a certain period.

The duration of each operation and the number of times the seed is so treated varies. Different workers have omitted one or more of these operations. In the experiments described here, operation 4, viz., heating the seed, was omitted as it presented practical difficulties to paddy cultivators in this country. Operation 2, viz., keeping the seed in air in a wet condition, was fixed at 6 hours except in the earlier experiments when seed soaked for ½ an hour was kept wet for 24 hours and that soaked for 12 hours and 24 hours was not kept wet at all. Operation 3, viz., air-drying the seed, was done till it was completely dry. Factorial designs were used for all the trials in which the variable factors were the period of soaking which was varied from ½ hour to 24 hours, and the number of times the seed was treated which was from 1 to 4. There were 6 replicates, 3 of which received regular irrigation and the other 3 reduced irrigation, viz., every other irrigation in order to simulate conditions of drought.

The treatments in all the trials described in this paper have been represented for the sake of simplicity and brevity, by means of 3 numbers separated by strokes, e.g., 2/6/2. The first number gives the period of soaking the seed in water in hours ; the second number gives the period of keeping the soaked seed in air in a wet condition in hours ; and the third number gives the number of times the seed is treated. Thus treatment 2/6/2 means the seed was soaked in water for 2 hours and kept in air in a wet condition for 6 hours and dried under shade till the seed was completely dry, after which the same treatment was given once more. This method of representation of the treatments has been used in the text as well as in the Tables of this paper. The seed was broadcast in all the trials.

RESULTS AND DISCUSSION

Effect on drought resistance

The effects of pre-sowing treatment in inducing drought resistance were demonstrated by the results of the trial carried out at Karadiyan Aru Farm with *Vellaiperunel* 28724 for *yala* 1950. The results are set out in Table I.

TABLE I

Results of the pre-sowing treatment trial with *Vellaiperunel* 28724 at Karadiyan Aru for *yala* 1950

Size of plot = 29 ft. × 10 ft.

Nett harvested area = 27 ft. × 8 ft. = 0·0050 acre.

Layout—4 × 3 factorial plus an untreated control, viz., 13 treatments with 6 randomized replicates. 3 of which received normal irrigation and 3 received reduced irrigation.

Treatment	*Normal irrigation*		*Reduced irrigation*		*Total***	
	Yield in lb./acre	*Per cent. of control*	*Yield in lb./acre*	*Per cent. of control*	*Yield in lb./acre*	*Per cent. of control*
0/0/0 (control)	1,453·3	100·0	1,193·3	100·0	1,323·3	100·0
½/24/1	1,513·3	104·1	1,553·3	130·2	1,533·3	115·9
½/24/2	1,460·0	100·5	1,513·3	126·8	1,486·7	112·3
½/24/3	1,693·3	116·5	1,046·7	87·7	1,370·0	103·5
2/6/1	1,640·0	112·8	1,286·6	107·8	1,463·3	110·6
2/6/2	1,540·0	106·0	1,193·3	100·0	1,366·7	103·3
2/6/3	1,346·6	92·7	1,093·3	91·6	1,220·0	92·2
6/6/1	1,553·3	106·9	1,213·3	101·7	1,383·3	104·5
6/6/2	1,540·0	106·0	1,000·0	83·8	1,270·0	96·0
6/6/3	1,306.6	89.9	973·3	81·6	1,140·0	86·1
12/0/1	1,620·0	111·5	1,386·6	116·2	1,503·3	113·6
12/0/2	1,106·6	76·1	1,053·3	88·3	1,080·0	81·6
12/0/3	1,146·6	78·9	826·6	69·3	986·7	74·6
Standard Error	141·3	9·7	141·3	11·8	100·0	7·6
Significant difference (P = 0·05)		27·4		33·4		21·4

Normal irrigation was significantly superior to reduced irrigation, but under conditions of normal irrigation the highest yield obtained was 16·5 per cent. over control, i.e., when the seed was treated thrice with ½ hour soaking periods (½/24/3), whereas under reduced irrigation the highest yield was 30·2 per cent. over control, i.e., when the seed was treated once with a ½ hour soaking period (½/24/1). It is clear, therefore, that pre-sowing treatment is more effective under conditions of drought. The beneficial effect of pre-treating the seed before sowing under dry conditions could be judged by comparing the yield figures. The untreated seed yielded 1,193·3 lb. per acre under restricted irrigation ; but when the seed was pre-treated by soaking for ½ an hour, the yield increased to 1,553·3 lb. per acre which was even more than the control of the normally irrigated plots, i.e. 1,453·3 lb./acre. In other words, the crop from pre-treated seed grown during drought gave a higher yield than the crop from untreated seed grown under normal conditions.

** Significant at the 1 per cent. level.

Since the best treatment under normal irrigation was ½/24/3 and that under reduced irrigation was ½/24/1, it follows that a more drastic treatment is necessary to produce the best effects under wet than under dry conditions. It is, of course, conceded that the treatment benefits in Table I are non-significant.

Effect on yield

It will be noticed that although the percentage increases in yield due to the treatments were more under dry conditions than under conditions of normal water supply, the increases under the latter were quite substantial. It has been quite clearly shown in all the trials carried out that apart from inducing drought resistance, pre-sowing treatments actually increase the yield. The magnitude of the increases obtained as well as the treatments which produced the highest yields varied for different varieties, although the significance of interactions has not been demonstrated.

(*a*) *Vellai Ilankalayan* 28061 (age—4 months).

The results of three trials carried out with *Vellai Ilankalayan* 28061 at Karadiyan Aru Farm for *maha* 1949/50 and at Karadiyan Aru and Unnichchai Farms for *maha* 1950/51 are given in Tables II, III and IV respectively.

TABLE II

Results of the pre-sowing treatment trial with *Vellai Ilankalayan* 28061 at Karadiyan Aru for *Maha* 1949/50

Size of plot = 42 ft. × 12 ft.
Nett harvested area = 40 ft. × 10 ft. = 0·0092 acre.
Layout—4 × 3 factorial plus an untreated control, viz., 13 treatments with 6 randomized replicates.

Treatment	*Yield in lb./acre*	*Per cent. of control*
0/0/0 (control)	1,402·2	100·0
½/24/1	1,371·4	97·8
½/24/2	1,380·4	98·4
½/24/4	1,476·4	105·3
2/6/1	1,518·1	108·3
2/6/2	1,494·6	106·6
2/6/4	1,500·0	107·0
6/6/1	1,503·6	107·2
6/6/2	1,583·3	112·9
6/6/4	1,581·5	112·8
24/0/1	1,434·8	102·3
24/0/2	1,411·2	100·6
24/0/4	1,365·9	97·4
Standard Error	24·6	1·75

Significant at the 1 per cent. level.
Significant difference (P = 0·05) = 4·9 per cent.

In the first trial, the results of which are presented in Table II, treatments 6/6/2 and 6/6/4 gave the highest yields. On analysis of the factorial scheme it was seen that the soaking periods and the interaction between the soaking periods and the number of times of treatment, were both significant at the 1 per cent. level. The number of times of treatment, however, was

not a significant factor. As the period of soaking was increased from ½ hour to 6 hours the yield also increased significantly but at 24 hours the yield dropped. It was probable, therefore, that the optimum period of soaking was around 6 hours or between 6 and 24 hours.

Two trials were, therefore, set down—one at Karadiyan Aru and the other at Unnichchai Farm in the following year—to test this hypothesis. As shown in Tables III and IV the period of soaking was varied from 6 to 20 hours at Karadiyan Aru and 4 to 16 hours at Unnichchai. The complications introduced by varying the period of keeping the soaked seed in air in a wet condition, were eliminated in these experiments by fixing this period at 6 hours. The results at Karadiyan Aru, although not significant, showed that treatment 10/6/2 was the best. The treatment differences at Uunichchai were significant at the 5 per cent. level. 12/6/2 was the best treatment which gave a significant increase in yield of 46·5 per cent. over control. Variance analysis of the factorial scheme revealed that the 12-hour period of soaking was the best and was significantly superior to 4-hour and 16-hour periods of soaking. The interaction between the periods of soaking and number of times of treating the seed did not reach the level of significance in this trial. But the existence of a clear interaction between these 2 sets of factors could be observed generally in all the three trials. For the shorter periods of soaking (i.e., ½-4 hours), the highest yields were obtained when treated three or four times. Long periods of soaking (i.e., 16 hours and over) gave the highest yields when treated once. The intermediate periods of soaking (i.e., 6–14 hours) responded best when treated twice. With *Vellai Ilankalayan* paddy the largest increase in yield, however, was obtained when the seed was pre-treated twice with 12-hour soaking periods.

TABLE III

Results of the pre-sowing treatment trial with *Vellai Ilankalayan* 28061 at Karadiyan Aru for *Maha* 1950/51

Size of plot = 42 ft. × 12 ft.
Nett harvested area = 40 ft. × 10 ft. = 0.0092 acre.
Layout—4 × 3 factorial plus an untreated control, viz., 13 treatments with 6 randomized replicates.

Treatment	*Yield in lb./acre*	*Per cent. of control*
0/0/0 (control)	1,574·3	100·0
6/6/1	1,565·2	99·4
6/6/2	1,556·2	98·9
6/6/3	1,614·1	102·5
10/6/1	1,668·5	106·0
10/6/2	1,798·9	114·3
10/6/3	1,710·1	108·6
14/6/1	1,603·3	101·8
14/6/2	1,688·4	107·2
14/6/3	1,654·0	105·1
20/6/1	1,755·4	111·5
20/6/2	1,567·0	99·5
20/6/3	1,481·9	94·1
Standard Error	79·2	5·03

Not significant at the 5 per cent. level.

TABLE IV

Results of the pre-sowing treatment trial with *Vellai Ilankalayan* 28061 at Unnichchai for *Maha* 1950/51

Size of plot = 42 ft. × 12 ft.
Nett harvested area = 40 ft. × 10 ft. = 0.0092 acre.
Layout—4 × 3 factorial plus an untreated control, viz., 13 treatments with 4 randomized replicates.

Treatment	*Total No. of tillers per treatment in thousands*	*Yield in lb./acre*	*Per cent. of control*
0/0/0 (control)	97·5	1,635·9	100·0
4/6/1	123·9	1,668·5	102·0
4/6/2	122·1	1,701·1	104·0
4/6/3	113·8	1,877·1	114·7
8/6/1	128·0	1,831·5	112·0
8/6/2	127·8	2,016·3	123·3
8/6/3	115·0	1,712·0	104·7
12/6/1	113·1	1,638·6	100·2
12/6/2	139·2	2,396·7	146·5
12/6/3	109·0	2,135·9	130·6
16/6/1	117·5	1,728·3	105·6
16/6/2	90·0	1,652·2	101·0
16/6/3	88·1	1,475·5	90·2
Standard Error		156·5	9·57

Significant at the 5 per cent. level.
Significant difference (P = 0·05) = 27·4 per cent.

(*b*) *Oddavalan* 2449/20 (age—3¾ months)

The results of the trial carried out with *Oddavalan* 2449/20 at Karadiyan Aru Farm for *yala* 1951, are given in Table V.

TABLE V

Results of the pre-sowing treatment trial with *Oddavalan* 2449/20 at Karadiyan Aru for *Yala* 1951

Size of plot = 42 ft. × 12 ft.
Nett harvested area = 40 ft. × 10 ft. = 0.0092 acre.
Layout—4 × 3 factorial plus an untreated control, viz., 13 treatments with 6 randomized replicates.

Treatment	*Yield in lb./acre*	*Per cent. of control*
0/0/0 (control)	1,016·3	100·0
½/6/1	1,175·7	115·7
½/6/2	1,440·2	141·7
½/6/3	1,257·2	123·7
3/6/1	1,387·7	136·5
3/6/2	1,356·9	133·5
3/6/3	1,380·4	135·8
6/6/1	1,489·1	146·5
6/6/2	1,317·0	130·0
6/6/3	1,197·5	117·8
9/6/1	1,293·5	127·3
9/6/2	1,101·4	108·4
9/6/3	1,257·2	123·7
Standard Error	102·2	10·1

Not significant at the 5 per cent. level.

The treatment differences were almost significant at the 5 per cent. level. The best treatment was 6/6/1 which gave an increase of 46·5 per cent. over control. Analysis of variance of the factorial scheme showed that none of the factors was significant, but there were indications that the general observations on *Vellai Ilankalayan* applied to *Oddavalan* also. The existence of an optimum period of soaking and an interaction between the soaking period and number of times of treatment could be discerned.

(c) *Vellaiperunel* 28724 (age—3 months)

The results of the first trial with *Vellaiperunel* 28724 have been presented already in Table I. The best treatment in this trial was ½/24/1 but even this did not show significant superiority over control. Analysis of the factorial scheme revealed that the period of soaking as well as the number of times of soaking were significant at the 5 per cent. and 1 per cent. levels respectively. The ½–hour soaking period was superior to all other periods ; and pre-treating once was significantly superior to two and three times. The results suggested that the optimum soaking period for this variety of paddy was less than 2 hours.

Another trial was, therefore, set down with *Vellaiperunel* paddy at Unnichchai for *yala* 1951, in order to determine the optimum soaking period. The following periods were tested :—

¼ hour, ½ hour, ¾ hour, 1 hour, 1½ hours, and 2 hours.

Unfortunately the land on which this trial was set down turned out to be saline in patches, and this resulted in loss of stand of the crop in some plots. The damage in these plots varied from 5–80 per cent. Hence analysis of variance was not attempted and the results are not reported in this paper. There were, however, indications that the optimum soaking period was 1 hour. The best treatment was 1/6/1, which yielded 19·7 per cent. over control.

It has been clearly shown from the foregoing results that marked yield increases were obtained due to pre-sowing treatment in the 3 varieties tested. The maximum increases obtained were 19·7 per cent. for *Vellaiperunel*, 46·5 per cent. for *Oddavalan*, and 46·5 per cent. for *Vellai Ilankalayan*. The treatments which produced these increases were pre-soaking once for 1 hour ; pre-soaking once for 6 hours ; and pre-soaking twice for 12 hours respectively for the three varieties. It would be noticed that the longer-aged paddies required longer periods of soaking to produce the best results, but the soaking periods were not proportionate to their ages.

Effect on Growth and Development

Investigations have been commenced on the quantitative effects of pre-sowing treatment of the seed on the growth and development of the plants. The results are not available yet and will form the subject of a

subsequent paper. Preliminary observations on the trials which have been described earlier, however, reveal some interesting features. The treated seed germinated 1–3 days earlier than untreated seed. A tendency towards shortening the age of the plants at 50 per cent. flowering was observed when the seed was pre-soaked for short periods of time; whereas in the case of the 24-hour soaking treatments, the plants flowered about a week earlier than control. The shortening of the age was more than could be accounted for by earlier germination. The treatments also induced increased tillering and consequently a larger number of earheads per plant, and this may have contributed to increased yields. In the trial reported in Table IV, the correlation coefficient between the number of tillers and yield for the different treatments, was found to be + 0·64 which was significant at the 5 per cent. level. The rate of increase in height of the treated plants was found to be greater than that of the untreated in the early stages, although marked differences were not observed in the final heights attained by the plants.

It is useful to consider briefly the theoretical basis of drought resistance induced by pre-sowing treatments. This treatment is actually a modified form of the process of hardening plants for drought resistance. Hardening is effected by growing the plants under conditions of insufficient moisture. In the case of pre-sowing treatment the process of hardening is carried out when the plant is in the embryo stage by drying the soaked seed. In other words, the seed itself is hardened. Hardened plants have been shown by a number of workers (6, 7, 8) to accumulate carbohydrates especially hemi-celluloses and sugars in their cells. Even when such plants are brought back to conditions of sufficient water supply the carbohydrate content remains higher than in plants which were not hardened. This condition established during the process of hardening becomes more or less irreversible. There is thus a permanent increase in the carbohydrate content of the cells of hardened plants which may bring about a permanent increase in their water-retaining capacity in two ways. First, the soluble carbohydrates increase the osmotic pressure of the cells and secondly, the hemi-celluloses which are hydrophilic colloids of high imbibition capacity increase the bound water content of the plants. These two conditions, to a certain extent, counteract dehydrating influences and enable the plants to withstand subsequent drought.

The increased rate of growth and development of the plants culminating in higher yields is attributed to the increase in metabolic activity caused by the pre-sowing treatment (1, 2, 6, 9). The way in which these metabolic processes are intensified is not clear. It appears possible that enzyme reactions play a part in this intensification (9).

The objects of this investigation which were set out earlier in the paper, have been achieved to a great extent. But many aspects still remain to be investigated. Further experiments, therefore, have been initiated to ascertain—

(*a*) the optimum period of keeping the seed in air in a wet condition after soaking;

(*b*) the period for which the pre-sowing treatment will remain effective;

(*c*) the effect of transplanting seedlings obtained from pre-treated seed;

(*d*) the best pre-sowing treatment for other varieties of paddy; and

(*e*) the quantitative growth changes caused by the treatments.

The results of these experiments will be reported in due course; but in the meantime it must be stated that the practical value of pre-sowing treatment, especially in places where paddy is grown purely or partly under rain-fed conditions, is clear.

SUMMARY

1. The possibility of inducing drought resistance of paddy by pre-sowing treatments consisting of repeated soaking in water and drying of seed was investigated at Karadiyan Aru and Unnichchai Farms in the years 1949 to 1951.

2. The results of these experiments have shown that pre-sowing treatment induced greater endurance to drought, produced higher yields and generally accelerated growth and development of the plants.

3. The maximum increases in yield obtained as a result of pre-sowing treatment were 19·7 per cent. for *Vellaiperunel* 28724, 46·5 per cent. for *Oddavalan* 2449/20, and 46·5 per cent. for *Vellai Ilankalayan* 28061. The treatments which produced these yield increases varied for the different varieties.

4. The theoretical basis of the effects of pre-sowing treatment is briefly discussed.

5. The plan of further work is outlined.

ACKNOWLEDGMENTS

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A Preliminary Note on an Unrecorded Group of Paddy Varieties Occurring in Ceylon

BY

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INTRODUCTION

DURING the course of a study of the varieties of the North-Central Province of Ceylon it was noticed that thirty varieties belonging to the 45–60 days age *[1] class possessed similar morphological and physiological characters. These were consequently included in a single group, which is referred to here as the Heenati group. These varieties are normally sown in Yala *[2] under small irrigation tanks with restricted water supply and have evidently been grown in Ceylon for centuries. Attention in this note is confined to a description of the characters of this group of varieties.

MORPHOLOGICAL CHARACTERS OF THE HEENATI GROUP

Sterile glumes	..	Sterile glumes are larger than normal. Adaxial glumes are truncate with irregularly defined or almost serrate upper margins. The number of the teeth on the upper margin vary between 5 and 6. The Adaxial glumes are lanceolate but the tips are blunt and end in one to three tooth-like projections. (Plate 1)
Pedicel Attachment	..	The pedicel attachment is tranverse or very slightly oblique ; in other Ceylon varieties it is markedly oblique or almost vertical. (Plate 1)
Pubesence	..	All parts of the plant are strongly pubescent particularly the upper surface of the leaves peduncle, rachis and rachilla.
Pigmentation	..	There is an uniform type of anthocyanin pigmentation throughout the group. The leaf axil, stigma, apiculus and leaf sheath are always a very faint pink. This colour is often hardly visible and can only be seen with a lens. The rest of the plant is unpigmented.
Plant Habit	..	The angle of tillering varies from 40°—50° and the tillers are geniculate.

*[1] Interval from sowing to flowering. *[2] South-West Monsoon Season.

There is very little variation in grain size and shape. Grain measurements revealed no bigger differences between the varieties than would be expected to occur between strains or races of the same variety. The measurements of twelve varieties are presented in Table 1. The average grain measurements of the varieties are :—

Mean Grain Length mm	*Mean Grain Breadth* mm	*Mean Grain Thickness* mm	*Length/Breadth Ratio*	*Length/Thickness Ratio*
6·94	2·98	1·99	2·32	1·48

[For Table 1 see page 27.]

PHYSIOLOGICAL CHARACTERS OF THE HEENATI GROUP

During the course of breeding work it was noticed that these varieties showed responses to transplanting and sowing date that were different from those of the other varieties of the early maturing class. A study of the factors affecting heading duration* was consequently undertaken.

EFFECT OF TRANSPLANTING

The effect of transplanting on heading duration of 40 Heenati selections taken at random from different Heenati varieties and 40 selections taken at random from other early maturing varieties was studied. The results are presented in Table 2. When broadcast the Heenati took on the average 56 days to head and the other selections 65 days. When transplanted the Heenaties took 76 days and other selections 73 days. Seedlings were transplanted when 3 weeks old. The extension of age in the Heenaties is 20±2 days and in the other varieties it is 8±3 days. An extension of age of 7–12 days is the normal effect of transplanting on most varieties.

TABLE 2.—Effect of transplanting on heading duration.

Variety	*Mean Heading Duration Broadcast*	*Mean Heading Duration Transplanted*	*Mean Increase in Heading Duration*
Heenati	55·8	76·4	20·6 ± 1·9
Other varieties	65·1	73·1	8·0 ± 3·3

The effect on heading duration of transplanting 2, 3, 4 and 5 weeks old seedlings was studied with five selections each representative of popular early-maturing varieties in the Province. The selections are Heenati 1596, Suduwi 1595, Kannimurunga 1627, Pachaiperumal 2462/11 and Kalu Heenati 1667. Of these only 1596 belongs to the Heenati group. The results are given in Table 3.

* The interval from sowing to flowering is defined as heading duration.

TABLE 3.—Yala 1950. Effect of seedling age on heading duration

Selection	*Variety*	*Broadcast*	*2 weeks old seedlings*	*3 weeks old seedlings*	*4 weeks old seedlings*	*5 weeks old seedlings*	
1627	Murunga	61	64	67	66	62	72
1595	Suduwi	64	64	68	69	64	77
2462/11	Pachaiperumal	64	64	69	69	65	74
1667	Kalu Heenati	63	67	74	79	64	86
1596	Heenati	59	71	82	89	64	97

In all cases there is a progressive delay in heading duration with seedling age up to a maximum with 5 weeks old seedlings. The curves in all cases are similar except that Kalu Heenati is intermediate between Heenati and the other three selections, which are similar in their response. (Figure 1)

With the 5 weeks old seedlings two waves of flowering were noticed within each selection. The mean ages of each wave are presented in Table 3 column 8. It will be seen that heading duration in the first wave is almost the same as when broadcast. In a broadcast crop, primodium formation begins somewhere between the 30th and the 40th day from sowing and it is likely that some of the seedlings had already crossed from a vegetative to a reproductive state when transplanted. These seedlings flowered early while the others that were still in a vegetative state flowered late. No primodia were visible at the time of transplanting. Transplanting 6 weeks old seedlings should result in a heading duration almost equal to that when broadcast.

EFFECT OF SOWING DATE

100 selections from Heenati and other early maturing varieties were sown at two dates each year, viz : on the 8th January (Maha *) and the 10th June (Yala) 1949 and 1950.

TABLE 4.—Effect of sowing date on heading duration

Variety	*Mean heading duration in days*		*Difference between Yala and Maha in days*		
	Yala	*Maha*			
Heenati	55	60	—	5	± 1.2
Pachaiperumal	63	62	+	1	
Kalu Heenati	63	62	+	1	
Other 3 months varieties	62	58	+	4	± 0.7

The effect of sowing date on heading duration is small but nevertheless three types of response are observable, viz :

(1) Heading duration unaffected by sowing date. Pachaiperumal 2462/11 and Kalu Heenati 1667 belong to this class.

(2) Heading duration in Yala longer in Maha, which is the typical response of short-day varieties. Most of the varieties other than the Heenatis fall into this group.

* North-east monsoon season.

(3) Heading duration in Maha longer than in Yala, which is the response to be expected from long-day varieties. All the Heenati varieties fall into this group.

To test this hypothesis that the response is photoperiodic the five representative selections used above were given photoperiodic treatment.

EFFECT OF PHOTOPERIOD

Two sets of fifty seeds of each selection were sown, after sprouting under similar conditions in plots and thinned down to 25 plants per pot nine days from sowing. One set of pots from each variety was exposed to day light from 6 a.m. to 3 p.m., each day (i.e. a nine-hour photoperiod) and kept the rest of the time in the dark room. Photoperiodic treatment was commenced on the 10th day after sowing and continued till ear emergence. The other set of pots was exposed to normal day length in the open.

TABLE 5.—Effect of photoperiod on heading duration

Maha 1949–50 — Sown on 8.1.50

Selection	*Variety*	*Heading time 9-hour photo-period days*	*Control days*	*Difference between treated and control days*
1627	Murunga	49	59	—10
1595	Suduwi	50	60	—10
2462/11	Pachaiperumal	59	64	—5
1667	Kalu Heenati	70	67	+3
1595	Heenati	78	69	+9

The results obtained confirm the view that the response to sowing date is a photoperiodic response. The Suduwi and the Kannimurunga selections behaved like short-day plants, while Kaluheenati and Pachaiperumal are day neutral and the Heenati selections behave like long-day plants.

Effect of other factors .. An experiment was set down with the same selections to investigate the following factors on heading duration—

(1) Cultural treatment.
(2) Fertilizers.
(3) Spacings.

The treatments were ..

(1) Five selections, viz : 1595, 1596, 1627, 1667, 2462/11.
(2) Cultural treatments, viz : Broadcast and Transplanted.
(3) Two doses of nitrogen, viz : None and 40 lb. N per acre.
(4) Two spacings. 3″ × 3″ and 9″ × 9″.

Each plot was split into half, spacings were allocated to the sub-plots and other treatments to the main plots. Each treatment was replicated twice. Sprouted seed was sown in the nursery and on the broadcast plots on the same day. The variance analysis of sowing-to-emergence intervals, transformed to the square root scale appropriate to Poisson series, is presented in Table 6.

TABLE 6.—Analysis variance heading duration transformed to the square-root scale

	D.F.	*S.S.*	*M.S.*	*F*
Block	1	0·0033	0·0033	
Varieties	4	1·6125	0·4031	60·16*
Nitrogen	1	0·0009	0·0009	
Cultural	1	8·2561	8·2561	123·23*
Vx N	4	0·0792	0·020	2·95*
Vx C	4	2·2957	0·5764	80·60*
Nx C	1	0·0152	0·0152	2·268
Vx N X C	4	0·0119	0·0029	
Error (*a*)	19	0·1281	0·0079	
Total	39	12·4029	—	
Spacings	1	0·5255	0·5255	31·848*
Sx V	49	0·1550	0·0387	2·34
Sx C	1	0·1466	0·1466	8·88
Sx N	1	0·0011	0·0011	
Vx S X C	4	0·0216	0·0054	
Vx S X C	4	0·0486	0·0121	
Sx C X N	1	0·0033	0·0033	
Error (*b*)	23	0·3793	0·0165	
Total	79	13·3839		

All the main effects and the interaction variety X cultural treatments are significant at the 1 per cent. level. The interaction variety X Nitrogen is significant at the 5 per cent. level. As regards the effect of transplanting, the results confirm those obtained earlier. The results are given in Table 7. Heenati takes 22 days longer to head when transplanted.

Table 7

	Broadcast days	*Transplanted days*	*Differences*
Heenati 1596	61	83	+22
Kalu Heenati 1667	63	75	+12
Pachaiperumal 2462/11	64	67	+3
Suduwi 1595	62	70	+8
Kannimurunga 1627	61	71	+10

[For Table 8 see page 28.]

Flowering is delayed at the wider spacing. The interaction of spacings and variety is not significant. In Heenati 1596 however, the plants at the wider spacing takes 6 days longer to head than at closer spacing.

DISCUSSION

The North-Central Province varieties included in the Heenati group carry different local names and those commonly met with are, Heenati, Rathu Heenati, Kalu Heenati, Heen Heenati, Madael, Sudu Madael, Dhanala, Hatadawi, Matale Heenati, &c. Village names however are no guide as some varieties with the above names carry none of the Heenati characters and vice versa. These varieties all possess in common a number of characters which distinguish them from other varieties, viz: characteristic grain size and shape, sterile glumes, pedicel attachment, pubescence and pigmentation, and mark them out as belonging to a homogeneous group. There is variation within the group as regards simple monogenic and oligogenic characters such as palea and lemma colour and awning. It should be possible, therefore, to regard all these varieties as races or strains of the same variety. Out of a collection of varieties made in different parts of Ceylon it was observed that twenty-seven possess the distinguishing morphological characters of the Heenati group. There is considerable variation between varieties in grain size and shape as indicated in Table 8 and which distinguishes them as distinct varieties. Examination of the available material did not reveal any instances in which these characters were separated and it is likely that this is a case of plicomorphism. The evidence collected so far seems to indicate that the varieties of the Heenati group possess a distinct morphological pattern superimposed on a well defined pattern of physiological behaviour. The latter appears in some way to be related to the very short age of the varieties.

[For Table 8 see page 28.]

ACKNOWLEDGMENTS

I am deeply grateful to Dr. M. F. Chandraratne for the valuable help and guidance he has given me and to Messrs. H. Weeraratna and T. Kanthasamy for helping with the records.

TABLE 1—Some North-Central Province belonging to the Heenati Group

Variety	*Origin*	*Grain Measurement*					*Predominant*
		Length	*Breadth*	*Thickness*	*l/b*	*b/t*	*Palea and Lemma colour*
Heenati ..	Minneriya ..	7·012 ..	2·860 ..	1·980 ..	2·452 ..	1·444 ..	Straw
Sudumadael ..	— ..	7·044 ..	3·061 ..	2·036 ..	2·301 ..	1·330 ..	Straw
Madael ..	— ..	7·084 ..	2·892 ..	1·984 ..	2·449 ..	1·448 ..	Black
Matale Heenati ..	Wilachiya ..	6·984 ..	2·956 ..	1·948 ..	2·363 ..	1·517 ..	Dark brown furrows
Madael ..	Minneriya ..	6·932 ..	2·932 ..	1·880 ..	2·364 ..	1·559 ..	Straw
Heen-heenati ..	Kallanchiya ..	6·700 ..	3·068 ..	2·136 ..	2·184 ..	1·436 ..	Light brown furrows
Sudu Heenati ..	Kalediulwewa ..	6·936 ..	3·028 ..	2·008 ..	2·304 ..	1·450 ..	Straw
Ratu Heenati ..	— ..	6·932 ..	2·932 ..	1·880 ..	2·364 ..	1·560 ..	Dark brown wash
Hatadawi ..	Maha Illuppallama ..	6·936 ..	3·008 ..	2·004 ..	2·306 ..	1·501 ..	Black
Heenati ..	Eppawala ..	6·628 ..	3·060 ..	1·996 ..	2·166 ..	1·533 ..	Very light brown furrows
Heenati ..	Kahatagasdigiliya ..	6·896 ..	3·008 ..	2·060 ..	2·291 ..	1·460 ..	Dark brown furrows
Matale Heenati ..	Nuwaragampalatha West ..	7·156 ..	3·072 ..	2·032 ..	2·329 ..	1·512 ..	Light brown furrows

TABLE 8—Varieties from other parts of the Island with the Morphological characters of the Heenati Group

Variety	*Origin*	*Grain Measurements*					*Predominant*
		Length	*Breadth*	*Thickness*	*l/b*	*b/t*	*Pales and Lemma colour*
Yapalwelai	Vavuniya	7·916	2·988	2·100	2·649	1·423	Dark brown furrows
Karuthasaraat	—	6·804	2·784	1·924	2·444	1·447	Black
Hirigithiliyal	Matara	6·652	2·656	1·816	2·504	1·463	Dark brown wash
Mahasuduwee	Tanaliyadde	8·064	2·912	2·072	2·769	1·406	Very light brown furrows
Ratasuduwee	Kalutara	6·632	2·672	1·856	2·482	1·439	Straw
Heenati	Kurunegala	7·768	3·240	2·020	2·397	1·604	Straw
Kaluhetadawee	Kalutara	8·004	2·888	2·100	2·771	1·375	Black
Hatadawee	Matale	7·272	2·952	2·008	2·463	1·470	Light brown furrows
Pollal	Kalutara	7·084	2·632	1·948	1·691	1·351	Black
Kaluheenati	Kandy	7·284	2·800	2·088	2·639	1·375	Black
Dahatalawee	Keliliyapola	7·580	2·872	2·088	2·639	1·375	Black
Kaluheenati	Puttalam	7·864	3·104	2·040	2·533	1·516	Black
Heenati	Paranthan	7·124	3·024	2·104	2·356	1·437	Dark brown furrows
Karathasal	Periyakulama	7·164	2·820	1·972	2·540	1·430	Black
Kalukada	Kandy	8·236	2·840	2·016	2·900	1·409	Black
Kaluheenati	Colombo	7·892	2·944	2·136	2·681	1·378	Black
Heenatiwee	Kurunegala	7·284	2·908	2·028	2·505	1·434	Brown furrows
Kombila	Kalutara	7·624	2·848	2·092	2·677	1·361	Very light brown furrows

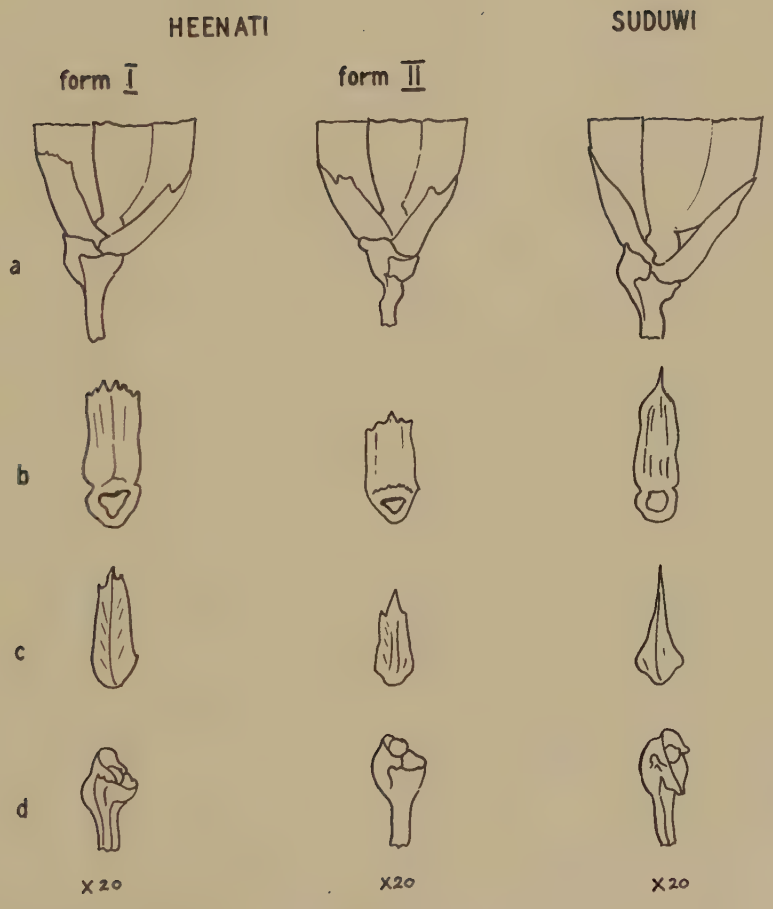

PLATE I. Illustrating differences between spikelet characters of the Heenati Group and Suduwi, which represents the usual types.

a. Spikelet b. Abaxial sterile glumes c. Adaxial sterile glumes d. Pedicel

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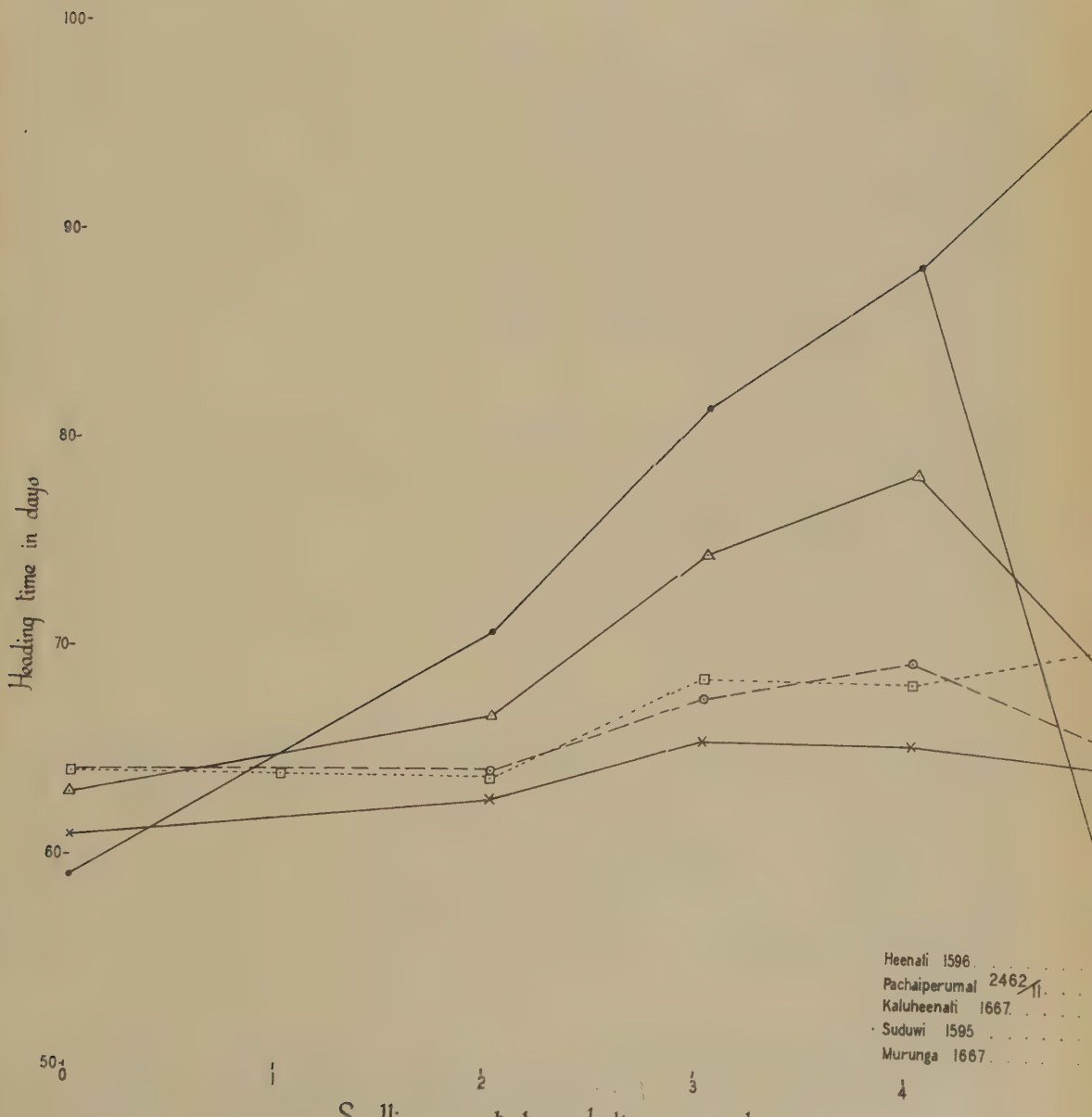

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Recent Advances in the Improvement of Cotton in Ceylon

BY

L. H. FERNANDO

LITERATURE on cotton in Ceylon records repeated attempts over a few hundred years at including cotton as an annual crop in the agriculture of this country. Conflicting reports of failure and success, and divergent views expressed by experts from abroad, indicate that in the instance of this particular crop, factors determining its performance in this country were not clearly recognized. Apart from the effect of economic and social factors—fluctuating world prices in cotton, the size of cotton holdings, and the incidence of malaria, for instance—the lack of precise information on the right variety and its requirements in soil, rainfall, locality and season, resulted in frequent failures. The success achieved in some instances, however, was encouraging, and kept alive the prospect of growing cotton in Ceylon.

All types of cotton have been grown in this country : these include the Asiatic cottons—*Gossypium arboreum* Linn. and *G. herbaceum* Linn., the American Uplands—*G. hirsutum* Linn., the Sea Islands and Egyptians—*G. bardadense* Linn. On the recommendation of Hilson in 1925, Cambodia, an upland variety introduced from India, was exclusively grown, until the Mills complained of its quality in 1937. The absence of a scheme of seed supply and purity maintenance was realized and the Botanist of the Department of Agriculture was requested to initiate a planned programme of cotton improvement.

Work commenced with the introduction of nineteen strains of medium and long-staple cottons from India and Africa during the period 1937–1941. The varieties from India included the Cambodia strains Co 2, Co 3 and Co 4, the Sind Sea-Island strain 2–4, and the Sind-Egyptian Boss III—16. The varieties from Africa included the long-staple Egyptian varieties Domains Sakel, X 1730 A and NT 2/38 from Sudan, the medium-staple varieties SG 29, BP 52, BP 79, BP 116 from Uganda, the Mwanzas 457, 561, 613 and local from Tanganyika and the South African U 4/4, 5143 Cambodia and 5143 Cambodia X 5143.

By 1944, these varieties had been tested in replicated field trials and the strain BP 79 was recommended for cultivation in Ceylon. The results achieved have been reported by Chandraratna in 1945. For the first time a variety that satisfied both grower and consumer was available. The Mills no longer complained of quality ; some of the cottons were, in fact, too long for their machines. Fibre tests on samples of BP 79 grown in Ceylon in

1945/46 were carried out by the Shirley Institute, Manchester, and it was reported that " in each count the Ceylon yarns were stronger and better in appearance than the Uganda yarns and on the whole this particular sample of Ceylon cotton compared very favourably with samples of Uganda BP 52. In each count the Ceylon yarns were less neppy than the BP 52 (Uganda) yarns ". The effective length in 32nds of an inch was 39 and the mean fibre weight per cm. was 152. A more recent report from the Shirley Institute on a sample of the 1949/50 crop shows the effective length at 36, the mean fibre weight per cm. at 147 and the Highest Standard Count at 55.

It should be mentioned that BP 79 has been considerably altered by selection since its introduction into Ceylon in 1940. In Uganda, BP 79 did not receive the same attention and was discarded. On a recent request from Uganda, seed of BP 79, selected in Ceylon, has been sent back to Uganda. The improvement effected in BP 79 and in the other introduced varieties was made possible by the method of selection and maintenance adopted by Chandraratna. Maintenance was not limited to a single plant in each variety. Instead, fifty to hundred plants were carefully selected, each season, on the basis of vigour, balanced vegetative growth and boll production, and finally on fibre qualities, judged by halo-length. The prevention of natural crossing between nineteen varieties, growing side by side on the same station, necessitated selfing of each of the plants selected. The produce of the selected plants in each variety provided seed for the maintenance plots in the next year. Selection and maintenance of purity proceeded hand in hand and was continuous from season to season. It was realized that continuous selfing, though necessary for the purpose of preventing cross-pollination between varieties, had the disadvantage of reducing to a homozygous state a heterozygous crop. The propagation of a single homozygous line, though acceptable for self-pollinated crops such as rice, is certainly undesirable for cotton. Propagation from fifty to hundred plants, provided a group of strains, each reduced to relative homozygosis by continuous selfing, but collectively possessing genetic variability and preserving the gene complex of the variety.

In the instance of the recommended variety BP 79 an additional safe-guard ensures purity of the variety : BP 79 is grown in isolation at Wirawila with no other varieties in its vicinity. Foundation seed is obtained by selecting and selfing, every season, 300 plants from an eight-acre maintenance block. The produce of the 300 plants sows the maintenance block in the next season. Seed from the eight acres is multiplied on an extent depending on the amount of seed available, usually 120 acres. The produce of the 120 acres forms the nucleus of pure seed which is further multiplied on stations of the Department of Agriculture, at Wirawila, and in various parts of the Island, before it is finally distributed free to growers. Fresh seed is supplied to cultivators every season. Maintenance and multiplication of seed therefore proceeds in stages every year. Selfing is limited to the 300 plants in the eight-acre block, the plants in the rest of the eight-acre

block and in the entire 120 acres being open-pollinated. Further multiplication provides at least three seasons of open-pollination before the seed is grown by cultivators. Natural crossing is possible in these three seasons, but can occur only between strains of the selected variety, restoring, at least partially, the heterozygosity of the selected variety. Two points in this method of purity maintenance are of considerable importance : (1) selection values are based on the performance of single plants, (2) repeated selfing of 300 plants in the eight-acre maintenance block leads to the production of inbreds. These received consideration and a change-over from the bulk plot of eight acres to replicated progeny rows, that accommodate separately the produce of the 300 selected plants, has now been effected. Selection values are determined on progeny rows instead of single plants. The discontinuance of selfing, the discarding of lines not conforming to desired standards and the selection of single plants from the remaining lines for propagation in rows in the following season, is being adopted, in accordance with Harland's Mass Pedigree System for cotton.

The progress made with BP 79 and with the crop in general can be judged by the rapid increase in the extent grown in cotton in post-war years. In 1944/45 five acres of experimental plots at Wirawila was the only cotton grown in the Island. In the next year, eight acres of BP 79 were sown at Wirawila for seed multiplication. In 1946/47 cultivators grew BP 79 for the first time ; sixteen acres was the total extent in cotton in the Island. The acreage increased to 372 in 1947/48 and 2,650 in 1948/49. Ten thousand hundredweight of cotton, entirely BP 79, was harvested in 1948/49. Never before had even half that quantity been produced in Ceylon. In 1949/50 the extent increased to 3,737 acres, but production fell to 2,800 cwt. This was an unusually adverse season with a rainfall of half the average. In 1950/51 the extent was 3,280 acres and production was again 10,000 cwt.

Although BP 79 fulfilled our requirements in yield and quality, and was generally acceptable, further testing of BP 79 against other varieties continued at the Cotton Station, Hambantota. Attention was confined to the medium-staple cottons, as these appeared most suitable for cultivation under rain-fed conditions. In the season *maha* 1948/49, fifteen varieties, grown in observation plots, covered a total area of 3·8 acres and gave a total yield of 55·5 cwt. of seed cotton, which was equivalent to an average yield of 14 cwt. per acre. Variety yields ranged between 9 and 19½ cwt. per acre. Co 4 and Co 2 gave 19½ and 17½ cwt. per acre respectively and outyielded BP 79 which gave 16 cwt. per acre. In respect of halo-length, however, BP 79 maintained its superiority over Co 2 and Co 4. In the next season *maha* 1949/50, BP 79 was tested against nine other varieties in replicated randomized blocks. The season was unusually adverse with a rainfall of half the usual average. The ten varieties yielded between 8 and 9½ cwt. per cwt. per acre, but did not differ significantly from each other. In the season *maha* 1950/51, eleven varieties were tested against BP 79, in three randomized blocks. An analysis of variance of yield indicated differences between varieties, significant at the one per cent. point (Table 1).

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TABLE 1.—Analysis of Variance

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*
Varieties	11	430·85	39·17	3·73*
Blocks	2	71·99	35·99	
Error	22	230·64	10·48	
Total	35	733·48		

* Variance ratio for significance at 1 per cent. point = 3·12.

The yields obtained were remarkably high and are given in Table 2. BP 79 was significantly outyielded by 5143 X Cambodia, Mwanza 561, Mwanza local, Co 2 and Co 3. S 5302, a strain related to BP 79 and recently introduced from Uganda, gave the lowest yield.

TABLE 2.—Variety Yields in Hundredweight

Variety	*Yield per acre*
5143 X Cambodia	22·06
Mwanza 561	21·59
Co 2	20·97
Mwanza local	20·41
Co 3	20·16
5143 Cambodia X 5143	19·19
Co 4	19 10
BP 52	17·34
Mwanza 457	16·84
BP 79	15·38
Mwanza 613	15·23
S 5302	14·70
Significant difference	3·95

The improvement of varieties in respect of yield and fibre qualities has been considered so far. Other factors, composing the locality and its environment, affect yield, and a discussion on this aspect follows.

Mee and Willis (1906) suggested that cotton can be grown " anywhere north of a line extending from Negombo to Trincomalee or south of one extending from Matara to Batticaloa. " We now know that the area suitable for cotton is not so extensive. In fact, Hilson in 1925 suggested that the Hambantota-Ambalantota-Liyangahatota tract was the most suitable for cotton. The deciding factors are rainfall and soil. It is well known that too much rain accompanied by water-logging of the soil, where drainage is unsatisfactory, particularly in heavy soils, can retard growth in cotton in the early stages and cause bud and boll-shedding later. In Ceylon, cotton is grown entirely rain-fed. A rainfall of 25–35 inches from sowing to harvest is considered satisfactory, but the distribution of rainfall is important. Rainfall distributions in the Hambantota District are given in Table 3. The advantage of sowing with the earliest *maha* rains at the end of September

or early in October is accepted, and though practised in *chenas* is not always possible where soil tillage is delayed for lack of rain. Flowering commences just two months from sowing. If sowing is done in early October, flowering occurs in December, just after the heavy rains in November. From December onwards occasional light showers are necessary to provide sufficient soil moisture ; too much rain interferes with flowering and setting, and can prolong vegetative growth at the expense of boll-production.

TABLE 3.—Rainfall distributions in the Hambantota District, averaged over a period of twenty years

	September	*October*	*November*	*December*	*January*	*February*	*March*	*Total September-March*
Hambantota	3·08	4·83	7·76	5·63	3·75	1·03	3·83	29·91
Tissamaharama	2·17	5·21	9·40	7·06	4·31	1·24	4·26	33·65
Ambalantota	2·63	6·03	7·81	6·90	3·56	0·90	3·76	31·59

It has been observed that flowering commences simultaneously in the full range of cottons tested in this country. The difference of less than a week between the first and last variety to flower, allows no separation into early and late varieties, at least in this country, except that some varieties extend their flowering duration, when soil moisture is not limiting, resulting in prolonged harvests. Dastur (1950) maintained that climatic conditions determine the rate of development and maturation in cotton. He stated that it was difficult to say precisely what the contributing climatic factors were, but was certain that temperature was one of them. In a study of the effect of climate on the same varieties of cotton grown in Sind and in Punjab, he found that flower buds were initiated at a critical minimum temperature of 82°F. This temperature was reached earlier in Sind than in Punjab, resulting in an earlier initiation of the flowering phase in Sind. After the initiation of buds, higher minimum temperatures favoured rapid development of buds into flowers, and flowers into bolls ; during this phase higher minimum temperatures prevailed in Sind than in Punjab. He considered climatic conditions more favourable for cotton in Sind than in Punjab. In Sind, maximum temperatures during the cotton season ranged between 107 and 76 degrees Fahrenheit and minimum temperatures between 82 and 50 degrees. In the Hambantota District of Ceylon, climatic conditions are even more favourable : the range of minimum temperatures during the cotton season is 65 to 80 degrees Fahrenheit ; the critical minimum temperature for flowering always obtains, and flowering is accordingly not delayed. At the same time, minimum temperatures are not too low to retard development and maturation. Harvests are completed five to six months from sowing, even when yields reach fifteen to twenty hundredweight per acre.

Spacing and manuring in cotton are other factors that have received attention. The spacings adopted by growers are surprisingly wide: four to six feet spacings with three or more seedlings per hill are not uncommon. On stations of the Department of Agriculture, a spacing of three feet by two feet, with two seedlings per hill is usual. An experiment, designed for the

purpose of investigating the effects of spacing, seedling number per hill, and levels of organic manure on three varieties of cotton was set down at Hambantota in the season *maha* 1950/51. The design of the experiment was factorial, with four factors, each at three levels. A single replicate, with nine blocks of nine plots each, accommodated the eighty-one treatment combinations. The main effects and first-order interactions alone were evaluated ; the higher order interactions, other than those confounded with blocks, were lumped in error. The analysis of variance of yield is presented in Table 4.

TABLE 4.—Analysis of Variance

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*
Main effects				
Varieties	2	174·83	87·42	13·21**
Seedling number/hill	2	22·67	11·34	1·71
Spacing	2	16·83	8·42	1·27
Organic manure	2	142·12	71·06	10·73**
First-order interactions				
Varieties × Seedling numbers ..	4	33·39	8·35	1·26
Varieties × Spacings	4	9·69	2·42	0·37
Varieties × Organic manure ..	4	24·26	6·07	0·92
Seedling numbers × Spacings ..	4	36·13	9·03	1·36
Seedling numbers × Organic manure ..	4	15·63	3·91	0·59
Spacing × Organic manure ..	4	50·07	12·52	1·89
Blocks	8	297·31	37·16	
Error	40	264·82	6·62	
Total ..	80	1087·75		

F values for significance = 3·23 (5%)* = 5·18 (1%)** ($n_1 = 2$, $n_2 = 40$)
= 2·61 (5%)* ($n_1 = 4$, $n_2 = 40$)

The differences between varieties and between levels of organic manure were found significant. The effects of spacings and seedling numbers per hill did not reach the five per cent. level of significance. None of the first-order interactions were significant. A summary of the results is presented in Table 5.

TABLE 5.—Summary of Results

Treatments	*Yield per acre (hundredweight)*
Varieties	
Co 4	16·13
BP 79	13·62
5143 C X 5143	16·84
Organic manure	
Nil	14·30
6 tons/acre	15·05
12 tons/acre	17·23

Treatments	*Yield per acre (hundredweight)*
Spacings	
36″× 9″	16·08
36″×18″	15·48
36″×36″	15·03
Seedling numbers/hill	
one	14·87
two	16·07
three	15·65
Significant difference ..	1·33

Increases in yield with the application of compost, though significant, were not striking. The increase in yield with six tons per acre did not reach the required level of significance ; the poor quality of the compost accounts for this. In regard to spacings and seedling numbers, there was no support for a change from the spacing of three feet by two feet with two seedlings per hill, which is adopted at present. This was particularly so for the variety BP 79 ; the other varieties did show some benefit from the closest spacing, viz., 36 inches by 9 inches.

The effects of organic and artificial fertilizers were investigated further at Hambantota in the season *maha* 1950/51, in a factorial design with three factors, each at three levels. The 27 treatment combinations were assigned to three blocks of nine plots each. Two replicates provided six blocks in all. A summary of the yields is presented in Table 6.

TABLE 6.—Summary of Yields

Treatments	*Yield per acre (hundredweight)*
Organic manure	
Nil	13·89
6 tons/acre	15·91
12 tons/acre	16·63
Sulphate of ammonia	
Nil	15·70
1½ cwt./acre	15·60
3 cwt./acre	15·13
Superphosphate	
Nil	15·55
1 cwt./acre	15·55
2 cwt./acre	15·33

There was no response to applications of sulphate of ammonia and superphosphate, confirming the results obtained at Hambantota in previous seasons. Joachim *et al.*, however, have demonstrated significant increases

in yield with applications of cattle manure (5 tons per acre) and with sulphate of ammonia (2 cwt. per acre) at Vavuniya and Pelwehera in 1936. The yield at Vavuniya was twice that at Pelwehera. The fact that cotton followed sunnhemp at Vavuniya needs emphasis. At Hambantota too organic manure was found beneficial, except in instances where the quality was poor or the quantity insufficient. It is possible that the lack of structure and organic matter in these soils results in a poor physical condition, particularly in respect of drainage, aeration and soil moisture. Under these conditions roots function inadequately and fertilizers are not fully utilized. The improvement of soil structure must therefore precede the use of artificial fertilizers.

ACKNOWLEDGMENTS

This contribution is a continuation of a project initiated by Dr. M. F. Chandraratna. I owe much to him for his guidance throughout these investigations. I wish to place on record my acknowledgment of the assistance given me by many officers of the Department of Agriculture in conducting these experiments. Mr. K. J. Gunawardena, in particular, contributed considerably by supervising these experiments in the seasons 1949/50 and 1950/51.

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A Programme of Progeny-testing Scindi Cattle at Polonnaruwa Livestock Farm

BY

P. MAHADEVAN

THE problem of evaluating the true breeding worth of different individuals in a given population is highly important both to the geneticist and to the practical breeder who aim at improving the production level of their stock. This is, however, rendered difficult for most quantitative characteristics such as milk production in dairy cattle, by the apparent lack of connection between phenotype and breeding value. Moreover, in dairy cattle, the value of the phenotype as a measure of genotype is further reduced by the fact that the males have no measurable phenotype themselves for milk production. In consequence, it becomes necessary to assess the probable genetic merit of a bull by the performance of his female progeny—a process which is known as " progeny-testing ".

Such a deliberate scheme of progeny-testing has now been started with the large herd of Scindi cattle at Polonnaruwa livestock farm which consists of about 800 head of animals. The results of this effort should come in gradually from about 1957–1958. The purpose of the present article is to outline the working of the progeny-testing scheme as envisaged at present, and to discuss related theoretical concepts.

Schemes very similar in principle to the present one, though differing in detail, have also been recently initiated with the Friesian herd at Bopatalawa and the Ayrshire herd at Ambawela. A scheme of progeny-testing in connection with artificial insemination in the area in and around Colombo, has also been suggested.

MAIN CONSIDERATIONS OF THE SCHEME

In arriving at the plan of action that is adopted at Polonnaruwa, the following points were given due consideration :—

(*a*) the number of young bulls to be tested ;
(*b*) the method of choosing young bulls ;
(*c*) the number of cows to be mated to each young bull.

It would be desirable to consider each of the above items in detail in order to understand the scheme.

Number of young bulls to be tested

For the progeny test to be of any value, it is essential that a sufficient number of young bulls should be tested each year in order that a choice may be exercised among them on the basis of their progeny records. It is by virtue of this fact that the value of progeny-testing in small herds is highly limited.

The number of bulls that could possibly be tested in such herds is small, and hence the intensity of selection between bulls after testing is low. Moreover, when young bulls have been mated to a sufficient number of cows to provide an adequate test of their breeding value, there would be few cows left on which to use the tested bulls. In fact, Dickerson and Hazel (1944)* have shown,by using the average genetic improvement per year as the criterion, that in a closed herd of 120 cows, the improvement is actually faster without progeny-testing. It must therefore be emphasized that a sufficiently large unit must be available for progeny-testing to be of any value.

The question of the number of bulls to be tested would then be dependent on the size of the unit. Given the same accuracy of testing, the superiority of the best of eight bulls tested will be, on the average, nearly three times that of the best of two, and the superiority of the best of four would be about two-thirds that of the best of eight. It is obvious therefore that the larger the number of bulls tested the greater are the chances of finding a bull of really high genetic merit. But, desirable as it is to test a large number of bulls, a severe limitation is however imposed in practice, by the size of the unit available for testing. To illustrate this point, let us consider a unit that has been testing (say) four young bulls every year. Any further increase in the number of bulls to be tested in this unit in a given time, would naturally lower the accuracy of testing by decreasing the number of cows that could be mated to each bull. This means that an increase in the number of bulls tested, while increasing the intensity of selection possible at the end of the test, lowers the accuracy of selection. And conversely, a reduction in the number of bulls tested, while increasing accuracy, lowers intensity of selection. It is evident therefore that the optimum structure of a progeny-testing programme is one which entails a balance between the number of bulls tested and the number of daughters per bull.

The progeny-testing scheme at Polonnaruwa, which commenced in October, 1951, brought into use four young bulls which averaged approximately two years in age at that time. These are used in addition to three other bulls already serving on the farm. It is proposed to use all seven bulls for service till the end of 1952. From January, 1953, they will be given only very occasional services until their progeny come into milk. To all intents and purposes, however, their place will be taken by a fresh batch of young bulls that have been already selected. It is also hoped to increase the number of young bulls on test to six from 1953, and they will be changed every year.

Method of choosing young bulls

Except for occasional selected importations from Pakistan, all young bulls for testing are chosen within the herd. The chief criterion for choosing young bulls for test is the age-corrected milk yields of their dams as compared with the contemporary herd average. The dams of selected bulls should come within about the top 5 per cent. of the herd, and would consist of second calvers or older cows. An additional criterion for selection, which would be

* J. Agric. Res. *69*, 459.

introduced after the first batch of bulls has been proven, is that the young bulls for test should come from among the progeny of proven sires.

In order to keep the interval between generations as low as possible and to minimize losses by disease, it is important that young bulls should be used for testing at as early an age as possible. To facilitate this, the plan of action at Polonnaruwa consists of selecting, well in advance, a few more than the actual number of bull calves that would be required for testing, feeding them on a high plane of nutrition so as to induce early maturity, and making the final choice among them, from the point of view of general appearance and body conformation, just before use. For example, the young bulls that are being progeny-tested at the present time, were chosen from a batch that was selected and put on a special feeding programme early in 1951. Similarly, for getting the progeny-test bulls for 1953, eight bull calves which averaged four months in age were selected in November, 1951, on the basis of their dams' performance ; these were put on a special feeding programme so as to get them ready for service by January, 1953, at which time a final selection will be made among them.

Number of cows to be mated to each young bull

There is considerable confusion in the minds of practical breeders as to the number of daughters required to test the breeding value of a bull. It is often assumed that at least 10 or 20 daughters are required per bull for such a test. If, however, the subject were viewed from a genetical standpoint, it can be shown that this assumption is meaningless and erroneous.

Let us suppose that we were testing a bull on the performance of his first 10 daughters. If these 10 daughters exceed the contemporary herd average by 100 gallons, it can be shown that, on the average, the next 10 daughters would exceed it by only 40 gallons. In other words, the heritability of a bull's performance based on 10 daughters is 0·4. Similarly, if the test were made on 20 daughters instead of 10, it is possible to show that the heritability on that basis would be 0·57. These figures, 0·4, 0·57, &c., derive from the figure 0·25 which represents the heritability of milk yield. (See Robertson and Rendel, J. Genetics, *50*, 1, 21.)

It would be evident from the above facts that as we increase the number of test daughters per bull, we obtain a better estimate of the bull's breeding value. If the bull were tested on as many as 200 daughters, for example, and if the production of these 200 daughters exceeded the contemporary herd average by 100 gallons, we would reasonably expect the next 200 daughters of this bull to show about 93 per cent. of this superiority. But, it is clearly impossible to go on increasing the number of test daughters per bull to such limits just for the sake of increasing accuracy, because it would reduce the number of bulls that could be tested in the unit, and, in consequence, the intensity of selection between bulls after testing would be lowered. As stated earlier, the problem, therefore, is essentially one of striking a balance between the number of bulls to be tested and the number of progeny per bull.

Giving due consideration to these two factors, the optimum structure of any progeny-testing programme can be calculated out from our knowledge concerning ordinal (ranked) data and the heritability of milk yield. Such a computation which uses the maximum genetic improvement per year as the criterion, shows that while about 15 to 20 bulls should be tested in every three-year period in a unit of 200 test cows, the corresponding number that could be tested to advantage in a unit of 1,200 test cows, on the other hand, is about 40 to 50 bulls.

It should therefore be clear that there can be no such thing as a minimum number of bulls to be tested or a minimum number of progeny per bull. The optimum structure of any progeny-testing programme will vary fairly widely with the size of the unit.

With the present size of herd at Polonnaruwa, it appears advantageous to test about 4 to 8 bulls each year and to aim at getting 15 to 20 milking heifers as the progeny of each bull. But with the increase in size of herd contemplated, it would be necessary to review the position every few years.

THE PROGENY TEST

To most practical breeders, the term " progeny test " connotes a comparison of the average production of the daughters of a bull with that of their dams. Although this conception of the progeny test may be valuable from a theoretical standpoint, its usefulness is however vitiated in practice by several factors. Firstly, it is natural that in any cattle breeding enterprise, other than in a specialized progeny-testing station, the dams would be a selected population as compared with their daughters, and the high performance of the selected dams would therefore be due only in part to their really superior breeding value. In consequence, the progeny test will be biased in that the dams are a selected group whose performance overrates their true breeding value.

The second factor that vitiates the usefulness of the daughter–dam comparison for progeny-testing purposes, is that there is generally, an interval of at least a few years between the time of production of the dams and that of their daughters. It is reasonable to expect the average yield of the herd to increase during this period, partly due to increasing skill with increasing experience on the part of the herd owner and partly due to improvements in methods of feeding dairy cattle that are taking place practically every year. On the other hand, it is also possible that there may have been a deterioration in management conditions between the time of production of the dams and that of the daughters, due, as for example, to erratic changes of staff including herdsmen and milkers. All these factors would therefore combine to bias any comparison that one may wish to make between the performance of dams and daughters.

It may perhaps be noted in this connection that in attempting to combat the above shortcomings caused by time trends, the New Zealand Dairy Board makes the comparison between dams and daughters on a within-year basis, i.e., by comparing the age-corrected butterfat yields of the dams

and daughters in the same year. A drawback to this method, however, is that any correction factors for age, by virtue of their methods of computation, are bound to include either environmental or genetic trends occurring within the herd.

The method that will be used for the progeny-testing work at Polonnaruwa consists of comparing the average production of the daughters of each bull with that of the other heifer contemporaries in the herd. This method has the advantage of being able to overcome the two main difficulties associated with the daughter–dam comparison. It has also the further advantage that the results will be expressed as deviations from the contemporary herd mean, thereby enabling the superior bull to be spotted without difficulty.

A word of warning is however necessary. For any progeny-testing work to be successful and unbiased, it is important that the cows to which each young bull is mated for testing, should form a random sample of the population. Furthermore, the daughters of these matings should be carried on as an unculled population till the end of their first lactations or at least till they complete their first ten weeks' yield. Any voluntary culling of heifers before this period would bias the progeny test.

Finally, a bull should not be considered fully proved until he has been tested for deleterious genes that he may be carrying in a recessive condition. It would therefore be advisable to mate the bull to a random sample of his own daughters for their first lactations. If no recessives appear, he may be considered fully proved.

DISCUSSION

The expected rate of genetic improvement under a programme of progeny-testing such as the one outlined above, would be about twice that possible under conditions of mass selection. To maintain this rate of improvement, however, it is important that adequate care must be taken to select young bulls for testing periodically. There is little point in using a good proven bull on all the cows in a herd if there is no other good bull to succeed him. The best policy would be to use him only on a certain proportion of the cows in the herd, and to use the rest of the cows for the purpose of testing his sons out of good dams and thus finding a good successor for him. The programme at Polonnaruwa envisages the use of proven bulls on one half of the herd only, while the other half would be used for testing young bulls.

It must also be noted that in any progeny-testing unit which breeds its own bulls for future use, there is always the risk of inbreeding cropping up at some time or other. As an insurance against inbreeding, it is therefore advisable to bring in occasionally, a small number of bulls for testing from outside sources. In the case of the Scindis, apart from importations from Pakistan which would serve to meet such contingencies, the other possibility of developing a number of independent non-related breeding units within the Island should not be overlooked. Although Scindi cattle are available at

present on several other government farms in the island, they do not really form non-related breeding units because they are all derived from Polonnaruwa stock. It is important, therefore, that if we are to be independent of importations from Pakistan, the development, in different parts of the Island, of at least semi-isolated breeding units of Scindi cattle, should be undertaken without delay.

Emphasis must also be placed on the fact that a progeny-testing programme does not end with the discovery of outstanding bulls. The dissemination of the superior genetic potentialities of such bulls forms an integral part of the programme, and artificial insemination provides the best means of furthering this end. With this idea in view, therefore, all progeny, test bulls should be trained for artificial insemination from as early an age as possible, so that once an outstanding bull has been found, the very best use could be made of him before he dies.

SUMMARY

A programme of progeny-testing Scindi cattle at Polonnaruwa has been started from October, 1951. The theoretical considerations involved in planning this programme are discussed.

The method recommended for the progeny test itself, consists of expressing the yields of the daughters of the bull under test, as a deviation from the performance of other heifer comtemporaries in the herd.

The expected rate of genetic improvement under the suggested scheme of progeny-testing is about twice that possible under mass selection.

REVIEWS

Forest Engineering: Roads and Bridges

BY

J. L. HARRISON

Published by Oliver and Boyd at 30 Shillings

THIS book should be of immediate practical use to farm managers and forest rangers a well as to the Ceylon P. W. D. who have recently been assigned the upkeep of many miles of minor roads, where a simple and cheap structure of local materials is preferable to the expensive and elaborate types of work of major highway construction.

From the angle of view of the practical man who is not particularly good with mathematical formulae, most of the formulae used are greatly simplified as compared with the older engineering textbooks, and in this book examples are worked out most clearly, particularly in the actual dimensions of timber bridges as determined from safe working stresses.

The book deals first with roads, giving most useful detailed instructions on the alignment, construction and maintenance of forest and minor roads, then in part two with a wide variety of bridge constructions of the kind which fall below the standard generally set for major public works. The illustrations, both photographic and diagrammatic, are clear and beautifully reproduced, thus greatly enhancing the value of the instructions. Most of the photographs are taken of Indian conditions but with the range of climate and river regime which one finds in India, the choice of methods and technique is very wide, in the case of bridges ranging from strutted and trussed timber spans, cantilevers built out of round logs, suspension bridges depending on wire rope, and culverts of stone, wooden box drains, pipes of concrete or galvanized iron sheeting. A minor omission which may be mentioned is a description of the open-work road grid which in many countries is now popular as a means of excluding grazing herds at a fence opening to take the place of a gate which the motorist has to get out to open.

The author rightly hangs all his road alignment drill upon the use of the Abney Level. This is a much more efficient and accurate instrument than the primitive "road tracer" which appears to be the standard equipment for both planters and government departments in Ceylon. In India this is known as a "Ghat Tracer", but the Indian pattern has a reasonably accurate screw thread on the cross bar, along which the pendent weight can be worked by very minute movements, thus constituting a considerable improvement on the one commonly used in Ceylon. Whether for laying out a road alignment or a contour bund or a lateral drain in tea, the Abney is undoubtedly far more effective and reliable than the road tracer. The simplest Abney with a 4-inch sighting tube and a vernier reading to 10 minutes is made by W. F. Stanley & Co. for £5. Those now reaching Ceylon from America are marked in percentages not in degrees. In this connection there is much confusion over the methods of measuring a slope, which the book

under review meets by giving a comparative list of gradients, angles of inclination and rise in feet per mile, but omits the American convention of percentage. Both gradients and percentages are readily applicable for the gentle slope of a road alignment, but for anything steeper such as measuring the side slope of a hill for a road cutting, the degree measurement is a more accurate and more readily visualized figure. For instance a 4 per cent. slope is the same thing as a 1 in 25 gradient, and measures 2 degrees 17 minutes angle, or a rise of 210 feet per mile ; a 100 per cent. slope is the same thing as a 1 in 1 gradient and measures 45 degrees or a rise of 5,280 feet per mile. To use the American Abney one must have a conversion table handy to give the corresponding degree or gradient data.

Some interesting data are given on the strengths of timbers as affecting bridge design and a well deserved tribute is paid to the late L. N. Seaman for his work in testing Indian timbers at Dehra Dun. The figures produced by him have been of great value, not only in governing the more economic use of tropical timbers in major construction works, but also in the war time adaptation of many useful but practically neglected timbers for such purposes as pick and shovel handles, felling axes, maul handles, &c.

In the treatment of both bridges and culverts to show the method of calculating the amount of flood water which must be expected from a given catchment, the author's choice of formulae is somewhat sketchy as compared with the rest of his work, and a description of how the catchment area can be found on the map and on the ground would have been helpful. This is a phase of road and bridge work which is usually skipped, with the result that a great many culverts and minor bridges are washed away because they have not been built to handle the amount of flood water passing through them in really heavy floods.

The author has included a chapter on river training works but it is too short to deal adequately with what is after all a fairly specialized kind of field engineering. His observations on the patterns of scouring and meandering by rivers are clear, and he gives a useful table of the lowest velocities which will allow a current to pick up, transport, and drop again various sizes of debris from coarse sand to flints the size of a hen's egg. But his highest velocity is 4 feet per second. One would like to have a similar table showing what, for example, the Mahaweliganga could carry in a 50-foot deep flood travelling at 17 feet per second, or the Walawe can do in the way of transporting a bed load of heavy material when it is passing down a good 100,000 cubic feet per second in its heaviest floods.

In describing the use of brushwood and piling spurs to revet and protect the eroding bank of a river, the author states that the worst angle for building these is at right angles to the flow of the current. So far, so good. But he then goes on to say that the best results are obtained with pointing the spur upstream and with the downstream face of the spur making an angle of 30 degrees with the direction of the streamflow. In American and Punjab practice the spurs are set the other way round, namely, heading 30 degrees with the current, with their bases upstream and their tails out in the flood. Experience in torrent correction shows that an appreciable amount of silting can be induced behind the shelter of such spurs, that is in the sheltered lee where the water, slowed up after filtering through the spur, drops part of its load of debris.

Other chapters cover quarrying and the blasting of rock, the building of retaining walls, and the use of metal clamps and connectors for strengthening the timber joints in roof and bridge trusses. Altogether an admirable book for anyone who has a job of work to do in the field.

R. M. GORRIE.

Bibliography of Cacao
Its history, cultivation, use, manufacture, and economic importance

BY

WOLF MUELLER

Verleg Gordian—Max Rieck—Hamburg 1951

RESEARCH workers and others interested in the cultivation and manufacture of cocoa in Ceylon will welcome this useful publication which appears at an opportune moment when much interest is being taken in the production of Ceylon cocoa because of the high prices it fetches in the World Markets. The demand for Ceylon cocoa continues to be good, and with the underplanting of many rubber estates to cacao in favourable localities the extent under cacao has shown considerable increase in recent years.

As stated by the Author in his preface which is in French, Italian, German and English, this bibliography is compiled from notes collected by him over a period of more than twenty years spent on research in connection with the preparation of an authentic " History of Cocoa and Chocolate" which is to be published shortly. It is divided into two sections, the first of which deals with publications of purely historical interest and other literature published during the period 1500 to 1900, and the second is in respect of literature published during the last fifty years.

The references to literature are given separately in each section under the names of the authors listed in alphabetical order, and an exhaustive subject index is provided at the end for easy reference. The second section alone contains 2,700 references, and covers almost fully the world literature on cacao. Nevertheless, as the author admits, it has not been possible to record all the published material from various parts of the world, and in order to make the publication more comprehensive and complete he invites authors and institutions to send their publications and corrections if any.

This Bibliography is published in Germany by the Editor of the Gordian, Hamburg, and contains advertisements by many leading continental manufacturers of chocolates and other cocoa products, and machinery for the manufacture of chocolate and cocoa.

It is altogether a very useful publication which should find a place in the library of all those interested in the production and manufacture of cocoa.

A. V. R.

Peradeniya, April 28, 1952.

SELECTED ARTICLES

Potash Review *

Review on the Effects of Potassium Deficiency in the Soil upon the occurrence of " Helminthosporosis " of the Rice plant

BY

TAKUKEN MATSUO, Tokyo

Report from : Ann. Phytopath. Soc. Japan, 13, No. 1–2, 10–13

THE article deals with the results of experiments which give an insight into which the effect the actual potash content has on the intensity of Helminthosporiosis on rice plants. Research was carried out on seedlings as well as on the leaves of mature plants, which were both artificially inoculated with stimulating cultures. The seedlings were cultivated in water, using the Kasugainutrient solution. Without any variation of the other nutrients, graduated doses of potash amounting to 0 mg., 10 mg., and 40 mg. were given in a series of three experiments. The pH value varied from 5·4–5·6. After a month's growth newly formed conidia were transferred by spraying and the intensity of the attack was noted after 3–4 days. It was quite obvious that the intensity of the disease decreased in proportion to the increase of K_2O content in the seedlings, in the following ratio : plants with an average supply of potash– 100, potash deficient plants– 129, plants with an abundance of potash– 81.

Similar experiments were also carried out on fully grown rice leaves of water cultivated plants and pot cultivated plants. The transfer of the conidia was also effected by spraying. The intensity of the infection could be noted after 5-6 days and was seen from the number of infected spots per 100 cm. of leaf length. The results of the experiments showed that both in the case of nutrient solutions and of soils with a constant nitrogen and phosphoric acid content the intensity of the disease decreased in proportion to the increase of potash applications.

The influence of a periodic potash deficiency was also examined. It was found that the susceptibility of the plant decreased according to the extent of the potash deficiency and the duration of this deficiency both in solution and in the soil. After transplanting in case of potash deficiency a weaker resistance to Helminthosporiosis was noted, yet after the period of vegetative growth a lessening of resistance to the disease was no longer apparent.

Further experiments dealt with the influence of potash deficiency on the infective power of spores. For this purpose conidia were taken from infected leaves and seedlings and put into a numidor at a temperature of 28 degrees C. for further development. Grown cuttings were infected with the newly developed conidia under the same conditions and their virulence noted according to the number of infected spots on the leaves. It was shown that the power

* Published by Kaliverttriebsstelle G. M. G. H, Landwirschaftliche Abteilung Ausland, Hannover.

of infection of the conidia corresponded to the respective potash deficiency of the infected plants from which they were taken. The more the growth of the original infected plant was influenced by potash deficiency, the stronger became the virulence decreased as a result of a more adequate potash supply.

The susceptibility of rice to this disease does not depend solely on the potash content but also on the N : P : K. ratio in the soil. Helminthosporiosis seems to appear in forms which are sometime caused by lack of nitrogen and sometimes by lack of potash. The latter form does not depend entirely on the absolute potash content of the soil, but also on the proportion of nitrogen to the amount of potash assimilated by the plant.

(Reference may be made to observations on the same subject in Agricultural Notes. Ed.)

AGRICULTURAL NOTES

Potash Deficiency in Paddy

POTASH deficiency as indicated in the form of leaf spots in paddy is fairly prevalent in the peaty or sandy soils along the Western coasts and in Unnichchai, Karadianaru and Vakaneri in the Batticaloa District, and the application of potash manures has corrected these symptoms. It was to meet this deficiency that potash was included in the mixture recommended by this Department for these tracts for paddy.

The trouble at Mirigama is known as " bronzing " where without the formation of leaf spots, the whole leaf beginning from the tip turns brown and dies. The Pathologist is of opinion that it is not caused by Helminthosporium. A number of comparative analysis of leaf samples collected from diseased and healthy plants from this area had indicated a very severe deficiency of potash in the affected leaves. Application of muriate of potash has shown some beneficial effect but the improvement does not appear to be commensurate with the quantity of potash applied and there seems to be something in the soil which prevents the full intake of potassium by the paddy plant under the conditions obtaining there. This problem is being further investigated.

How long the bronzing trouble has been in existence is not clearly known but it seems to have attracted attention only recently. Excess of nitrogen does predispose a plant to disease and it may be that the application of fertilisers not containing potash supplied by Government to soils normally deficient in this constituent aggravated the conditions or it may be due to the extention of cultivation of pure line paddy to areas low in potash where the local paddy by natural adaptation could satisfy its requirements.

No serious attention has been made to investigate the association of Helminthosporium attack with deficiency of potash in soil, but the work done in connexion with the serious outbreak of Helminthosporium in Badulla some years ago failed to show any correlation between the potash content of soil and the degree of incidence of the disease. It was, however observed, there too, that transplanted paddy was affected to a much higher degree than broadcast paddy.

S. KANDIAH.

The Clove Bean – Ipomoea Muricata (Jacq)

IPOMOEA muricata popularly referred to as the ' Clove bean ' and as *Alanga* in Sinhalese and *Mukutti kai* in Tamil is grown in vegetable gardens in Northern India, Malaya and Japan. It is not a true bean but a member of the same family (*Convolvulaceae*) as the sweet potato and the Morning Glory. It is a creeper with irregular outgrowths on the stems and it produces large pink flowers which open at dusk and close in the day. When the flowers set, the pedicels become fleshy and are edible. They may be curried and fried in the same way as the brinjal. When the pedicel is mature it tends to be fibrous but when young it is tender and palatable.

A few seeds of two varieties were sown at the Experiment Station, Peradeniya. One variety has slightly larger dark green pedicels with black seeds while the other variety has smaller pale green pedicels with white seeds. About two or three seeds should be planted per hill at a spacing from about 3 ft. apart each way. The seeds germinate in 7–10 days and the creepers are required to be trained on trellises of bamboo or dead branches of trees. The plants are quick growing and come into bearing in about two months from planting. They need little attention and bear continuously for about 3 months. The clove bean is particularly suitable as an off season vegetable during the heavy rainy season when other vegetables are scarce and it can be grown without much effort in home gardens. The yield per creeper is about 2–5 lb.

E. P. Buell.

Drying of Cacao in Wet Weather

THE drying of cacao in wet weather is a problem that faces the small holder who does not possess the means of erecting elaborate flue-drying systems, such as is found on the large estates. The usual method employed in village holdings is to 'roast' the beans over a fire. This produces a slaty bean of poor quality.

A satisfactory drying floor based on a design provided by Mr. D. H. Urquahart, the late Director of Agriculture, Gold Coast, when he visited Ceylon in October, 1950, in connection with a survey of the cacao protentialities of tropical countries on behalf of Messrs. Cadbury Bros., Ltd., England, was erected at the School Farm. A 2½ in. wide trench was dug 15 ft. long,, 3 ft. deep at one end and sloping gradually to a depth of 3 in. at the other. The trench is covered with sheets of ¼ in. iron leaving a space of 2 ft. at the deep end for firing. It is desirable to fix a chimney of galvanized iron at the shallow end, unless the prevailing wind in the area can create a sufficient draught in the trench. The iron sheets are covered with a thin layer of sand on which the matting is laid. The whole arrangement is covered with a roof for protection from rain.

Firewood is burned in the pit at the end of the trench, the rest of the trench acting as the flue. Once the floor is sufficiently heated the firing pit is covered so that only smouldering embers remain in the pit. The cacao is dried on mats on the heated floor in the usual way.

This system may be used even on a large scale by having several such floors constructed parallel to each other under the same roof. Cacao dried on this floor is in no way inferior to flue-dried cacao.

V. E. A. Wikramanayake.

Preliminary Trials for the Control of the Water Fern (Salvinia)

OBSERVATIONS are given below from preliminary trials for the control of *Salvinia* on plots of 1/500 acre to 1/75 acre at Negombo and Katunayake with spraying two hormone weedicides, 24 Dn-butyl ester and 245 Tn-butyl ester, at strengths of ½ gallon, 1 gallon, and 2 gallons of the weedicide per 100 gallons of water used over an acre.

Spraying at a strength of ½ gallon followed by a second spraying 10 days later at the same strength was ineffective.

At a strength of 1 gallon followed 10 days later by a second spraying at the same strength, most of the aerial parts were killed after 5 days but at the joints of the stem new young plants were being produced. On the 18th day after the second spraying a third spraying was done at the same strength. Ten days later the original plants were dead, but most of the new young plants were growing and a fourth spraying was done at 2 gallons strength. Twenty days later most of the young plants were dead and a fifth spraying was given of the same strength. Nine days later practically all the plants were dead.

At a strength of 2 gallons followed 10 days later by a second spraying at the same strength almost all the aerial parts were killed after 5 days but from the joints of the stem there were new young plants. Eighteen days after the second spraying, a third spraying was done at the same strength. Twelve days later all the original plants were dead and also most of the new young plants and a fourth spraying was done at a strength of 4 gallons. Ten days later practically all the plants were dead.

These are therefore indications that these weedicides offer some promise for the control of this weed, but much more work is needed before any conclusions could be drawn.

J. E. Senaratne.

DEPARTMENTAL NOTES

Statement of Total Issues of Planting Material, Implements and Livestock during 1951 from Agricultural Divisions of the Department of Agriculture

1. *Seed and planting material*

Seed Paddy bush.	*Cotton B. P. 70 Cwt.*	*Kurakkan E 43 bush*	*Gingelly B 3 bush.*	*Green Gram (Glossy) bush.*	*Selected vegetable seed lb.*	*Chillies seedlings millions*	*(selected) Seed lb.*	*Maize selected bush.*	*Sorghum All (varieties) bush.*	*Rubber Clonal seed*	*Rubber Budwood yards*
138,784	972	370	233	220	2,940	52·65	7,478	392	993	55,448	480

Siruwhemp Bush.	*Cowpea Bombay bush.*	**Coconut seednuts Nos.*	*seedlings Nos.*	*Mango Grafts and seedlings Nos.*	*Citrus Grafts and seedlings Nos.*	*Plantaing suckers Nos.*	*Mangosteen Nos.*	*Jak Nos.*	*Bread fruit Nos.*	*Sapedilla Nos.*	*Kapok Seedlings Nos.*
845	677	15,000	42,196	20,780	48,813	1,937	949	29,372	6,113	2,905	61,950

Kapok Seed lb.	*Coffee seedlings Nos.*	*Cassava Cuttings Nos.*	*Sweet Potato cuttings*	*Other Yams cuttings or setts*	*Red Onion (Shallots) cwt.*	*Turmeric Cwt.*	*Miscellaneous cuttings (thousands)*	*Plants miscellaneous*	*Cuttings Grass*	*Groundnut Seed lb.*	*Pepper Vines*
530	241,277	97,650	52,200	307,000	260	7	230	88,994	158,650	1,385	225,259

2. *Livestock*

Stud bulls	*Young Bulls*	*Heifer Calves*	*Cows*	*Stud Buffaloes*	*Stud Goats*	*Nannies*	*Kids*	*Boars*	*Sows*	*Piglings*	*Fowls*			*Turkey*		
											Setting Eggs	*Cocks*	*Pullets*	*Betting Eggs*	*Stages*	*Pullets*
36	98	43	3	8	15	7	42	2	10	27	65,653	2,597	2,239	198	9	7

3. *Implements for paddy*

Ploughs		*Burmese Harrows*	*Intercultivators*	*Disc Harrows*	*Tractors*
Model C	*Model D*				
2,854	1,385	2,670	1	7	6

* Issued through the Department mainly from Coconut Research Institute nurseries.

Results of Paddy Demonstrations during Maha 1950-51 and Yala 1951

THE results of paddy demonstrations held in the various Divisions during the above seasons confirmed the general benefit of transplanting in the various districts of the Island in both seasons. Fertilizers generally resulted in an additional improvement in yield although results were not consistent in all districts. Transplanting together with the application of bulky organic manures has also given very good yield increases in all districts. Harrowing the standing crop has again proved advantageous but the results, as are to be expected, are not as marked as with transplanting in most districts. Weeding also increased yields but gave the lowest increases of all the treatments.

Results of Paddy Demonstrations

(Bushels per acre)

1 Transplanting

Maha 1950–51

Division	*No. of Plots*	*Control*	*Treated*	*Increase per cent.*
Northern	10	23·5	30·1	28
North-Central	31	41·7	63·1	51
Western	80	45	88·1	95
Central	7	31·4	40·7	30
Sabaragamuwa	94	40·3	59·8	45
Uva ..	261	29·1	46·6	60
Eastern	18	33·4	46·6	39
Trincomalee	10	45	64	42

Yala 51

Northern	3	25·1	32·2	28
North-Central	25	31·3	44·5	42
Western	45	39·4	59	61
Sabaragamuwa	10	33·3	47·3	42
Uva ..	374	29·8	51·7	73
Trincomalee	46	36·8	62·1	68

2. Transplanting plus fertilizers

Maha 1950–51

Northern	16	30·1	57·6	91
Western	54	46·5	82·3	76
Central	63	57·4	74·6	31
Uva ..	148	27·4	44·2	61
Eastern	26	42·1	70	66
Trincomalee	13	49·5	67	35

2. Transplanting plus fertilizers

Yala 1951

Division	*No. of Plots*	*Control*	*Treated*	*Increase per cent.*
Northern ..	5 ..	30·5 ..	49·9 ..	63
Western ..	2 ..	26 ..	34 ..	30
Central ..	27 ..	45·3 ..	75·3 ..	52
Uva	103 ..	40·1 ..	50·6 ..	26
Eastern ..	19 ..	40·5 ..	56·4 ..	39
Trincomalee ..	48 ..	37·5 ..	69·5 ..	85

3. Transplanting plus green manure, compost or cattle manure

Maha 1950–51

Northern ..	15 ..	37·5 ..	60 ..	60
North-Central ..	28 ..	41·3 ..	69·8 ..	69
Western ..	63 ..	50·4 ..	72·7 ..	44
Central ..	4 ..	45·6 ..	82·6 ..	81
Sabaragamuwa ..	11 ..	29·5 ..	48·6 ..	65
Uva	119 ..	33·9 ..	56·1 ..	65
Trincomalee ..	15 ..	49 ..	85 ..	75

Yala 1951

Western ..	19 ..	32·1 ..	59·3 ..	81
Central ..	2 ..	50 ..	68·7 ..	37
Sabaragamuwa ..	13 ..	51·2 ..	67·4 ..	31
Uva	260 ..	40·4 ..	51·2 ..	20
Trincomalee ..	54 ..	39 ..	75·3 ..	93

4. Harrowing the standing crop

Maha 1950–51

Northern ..	44 ..	26·5 ..	44·6 ..	68
North-Central ..	92 ..	26·8 ..	38·6 ..	44
Western ..	105 ..	35·9 ..	43·5 ..	21
Central ..	8 ..	43 ..	55·6 ..	15
Sabaragamuwa ..	13 ..	27 ..	50·5 ..	87
Uva	31 ..	26·6 ..	36·5 ..	37
Eastern* ..	32 ..	38·9 ..	50·4 ..	30
Trincomalee ..	7 ..	48 ..	67 ..	39

Yala 1951

Northern ..	43 ..	26·6 ..	31·7 ..	19
North-Central ..	59 ..	30·2 ..	43 ..	43
Western ..	83 ..	33·9 ..	44·9 ..	43
Central ..	23 ..	45·2 ..	57·7 ..	28
Sabaragamuwa ..	24 ..	28·5 ..	34·3 ..	20
Uva	28 ..	25·1 ..	31·7 ..	42
Eastern* ..	90 ..	32·3 ..	39·4 ..	22
Trincomalee ..	30 ..	37 ..	54·6 ..	47

* Harrowing the Standing crop plus fertilizers

5. *Weeding only*

Maha 1950-51

Division	*No. of Plots*	*Control*	*Treated*	*Increase per cent.*
Northern	3	19	22·3	16
Western	44	16·6	22·9	43
Central	3	43·1	55·1	28
Sabaragamuwa	5	47	54·3	14
Uva ..	110	25·8	30·5	18
Trincomalee	24	46·5	56·5	21

Yala 1951

Western	32	37·2	52·4	50
Central	8	30·7	44·1	44
Uva ..	72	24·8	29·3	17
Trincomalee	72	36	43	19

Courses of Instruction in Soil Conservation

A LARGE part of the job of soil conservation is educational, but the extent to which technical matters are taught in detail must naturally depend upon the previous training and educational status of one's audience. A simple single lecture on the elementary facts of soil erosion for the general public must avoid detail, but in a longer course of instruction this detail will naturally find a place.

By way of technical education, courses of 10 days have been given to mixed groups of Agricultural Instructors, Tea Small Holdings Officers, Tea Controllers' Inspectors, research staff from the research institutes dealing with tea, rubber and coconut and other similar grades employed on land use of some kind.

The staff of the Land Commissioner has been given a 3 day course dealing primarily with the problems of jungle clearing. And several district groups of planters have been given 2 day courses dealing chiefly with erosion in tea.

In all these courses some attempt has been made to convey the importance of water conservation as well as of soil conservation. The dangers of soil erosion have been apparent in Ceylon for many years, long before the 1931 commission on soil erosion, and most of the men working with field crops and commercial plantations are fairly fully aware of this. The value of recent research is to emphasise that erosion does not start with running water, but at the point where the rain-drop hits the ground. It is the rain splash which dislodges and dissolves the valuable clay particles, and so the real problem of stopping erosion lies in protecting the soil by cover crops and every other means which will shield the bare soil from direct attack. In water conservation the main theme has been the poverty of Ceylon's underground water-table and the necessity of building this up by every available means such as check dams, water holding dams, village tanks, contour ditches, diversions ditches and so forth. Flood control in the rivers forms an important phase in the newly made Soil Conservation Act and the technique of river bank protection by using suitable dense vegetation has been taught, but there is little of practical experience in this type of work along Ceylon's main rivers, though many planters have tried on their own initiative along smaller streams.

Recent experience in the field to field survey of crops and erosion conditions is related to show the purpose of our fact finding Land Use Survey and the way in which the facts are used to make up a plan for improved land use through agriculture, irrigation and forestry. Practical application of this is seen in the case of the Kotmale Landslips Area ; other nationally important river catchments will be taken up as staff become available.

R. M. G.

MEETINGS, &c.

MINUTES OF THE 119TH MEETING OF THE COCONUT RESEARCH BOARD HELD AT 2.30 P.M. ON WEDNESDAY, DECEMBER 12, 1951, IN THE LIBRARY OF THE GIRLS' FARM SCHOOL, KUNDASALE

Present.—(1) Dr. A. W. R. Joachim, (Chairman, Coconut Research Board and Director of Agriculture, Peradeniya).

(2) Thomas Amarasuriya Esq., Chairman, Low Country Products' Association.
(3) C. A. M. de Silva Esq., Small-Holders' Representative.
(4) E. Muttukumaru Esq., Small Holders' Representative.
(5) Col. W. C. Mack, Representative of the Planters' Association of Ceylon.
(6) R. H. Spencer Schrader Esq., Representing the Planters' Association.
(7) A. Gnanapragasm Esq., Representing the Low Country Products Association
(8) N. H. Keerthiratne Esq., M.P., Representing the House of Parliament.
(9) F. C. Cooke, Esq., Director, Coconut Research Institute.
(10) C. A. Abeyratne Esq., Representing the Low Country Products Association.

Mr. S. C. Kahawita (Secretary-Accountant, C.R.I.).
Mr. W. J. A. Van Langenberg was unable to be present owing to a previous engagement.

1. MINUTES

Minutes of the previous meeting held on October 27, 1951, which had been circulated were approved without amendment.

2. MATTERS ARISING OUT OF THE MINUTES.—COLOMBO PLAN EXHIBITION.

Correspondence regarding the Colombo Plan Exhibition which had been circulated was tabled and approved. The expenditure of Rs. 3,000 for a model which will remain the property of the Institute was approved. It was also agreed that C. R. I. Officers should be on duty at the Exhibition during the period of the Exhibition.

SUB-COMMITTEE. MINUTES OF THE RE-ORGANIZATION SUB-COMMITTEE

The Board approved the minutes of this Sub-Committee except for the last para on *Finance*, which was referred to the Administration Committee for consideration and report.

Census of Coconut Areas.—The Chairman reported that Mr. R. S. Koshal, the F. A. O. Statistician was invited to be present at the Board Meeting was unable to do so as he was away in India. He will, it is hoped, be present at the next.

Any Other Business.—Regarding Col. W. G. Mack's proposal for propaganda and supervision of nurseries, the Board decided that these proposals should be examined by the appropriate Committee.

It was decided that the recommendations of the Board regarding the Marginal Committee Report should be published in the Quarterly.

The Soil Chemist's proposal regarding the Medical Aid Fund was referred to the Administration Committee.

As recommended by the Sub-Committee, the following were appointed to the Committees for a period of 1 year beginning January 1, 1952.

(1) *Administration Committee.*—

Chairman (Chairman, C. R. I.).
Treasury Representative,
C. A. M. de Silva Esq.,
A. Gnanapragasm Esq.,
Thomas Amarasuriya Esq.,
Director, C. R. I.

(2) *Research Committee.*—

E. Muttukumaru Esq. (Chairman),
R. H. Spencer Schrader Esq.,
Representative of the House of Parliament (R. Singleton Salmon Esq. M. P.)
A. Gnanapragasm Esq.,
Chairman of the Board,
Director, C. R. I.

(3) *Extension Committee.*—

Thomas Amarasuriya Esq. (Chairman),
Col. W. G. Mack,
N. H. Keerthiratne Esq., M.P.
C. A. Abeyratne Esq.,
C. A. M. de Silva Esq.
Director (Coconut Research Institute),

The meeting terminated at 5.30 p.m.

S. C. KAHAWITA,
Secretary Accountant,
Coconut Research Institute.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT 2.30 P.M. ON FRIDAY, DECEMBER 21, 1951, AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON, 113, STEUART PLACE, COLPETTY, COLOMBO

Present.—Mr. R. C. Scott, C.B.E. (Chairman) ; Dr. A. W. R. Joachim, M.B.E. (Director of Agriculture) ; Mr. R. C. L. Notley (Chairman, Planters' Association of Ceylon) ; Mr. R. S. Davies (Chairman, Agency Section, Planters' Association of Ceylon) ; Messrs. W. H. Attfield, H. de T. Wilkinson Kay, W. Neal de Alwis, J.P., U.M., R. M. Macintyre, V. G. W. Ratnayake, M,B.E., M.P, D. E. Hettiarachchi, J.P., U.M., Errol Jayawickreme, H. S. Hurst and J. Lamb (Director and Secretary).

Mr. F. C. Daniel, Superintendent, St. Coombs Estate, was present by invitation. Mr. A. H. Hall, Visiting Agent, St. Coombs, was also invited but was not able to attend.

1. NOTICE CONVENING THE MEETING WAS READ

Letters regretting inability to be present were tabled from Messrs. A. D. McLeod and A. G. Ranasinha, C.M.G., C.B.E., C.C.S. (Secretary to the Treasury).

The Chairman, on behalf of the Board, extended a cordial welcome to Mr. Lamb, the Director, who had recently returned from home leave.

2. THE MINUTES OF THE MEETING OF THE BOARD HELD ON SEPTEMBER 7 1951, WERE CONFIRMED.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

(*a*) Board

The Chairman reported that Mr. D. E. Hettiarachchi, J.P., U.M., had been nominated by the Low-Country Products Association to fill the vacancy created by the resignation of Mr. Leo. B. de Mel. This was effective from September 20, 1951.

He extended a hearty welcome to Mr. Hettiarachchi as a Member of the Board.

(*b*) Estate and Experimental Sub-Committee

The Chairman reported that Mr. E. G. Groves had resigned his seat on that Committee prior to his departure from the Island on retirement and with effect from December 31, 1951.

The Chairman expressed the appreciation of the Board for the very useful contribution made by Mr. Groves to the Institute in particular, and the tea industry as a whole, both as a member of the Board and of the Estate and Experimental Sub-Committee.

The Sub-Committee had recommended the nomination of Mr. Richard Leaning of Diyagama, Agrapatana, to fill the vacancy. Agreed.

4. SMALL HOLDINGS ADVISORY SERVICE

(*a*) Estimates.

At this stage, Mr. R. L. Illankoon, Officer-in-charge of the Small Holdings Advisory Service, was called in to the meeting and Item 7 on the Agenda viz., Small Holdings, Advisory Service, was taken up for disposal. Members of the Board had inspected the new propaganda unit before the meeting commenced.

The Chairman referred to the draft estimates which had been approved by the Small Holdings Sub-Committee and which had been issued to members together with the minutes of the inaugural meeting of the Sub-Committee held on October 1, 1951. The minutes of the meeting of the Sub-Committee held on November 19, had also been issued to members along with a report of the officer-in-charge.

Mr. V. G. W. Ratnayake on being invited to comment on the working of the service said that the organizaton had only been just set up, and had made satisfactory progress.

Mr. Illankoon also stated that he would not wish to make any comments at that stage but would like to report after about 3 months.

The draft estimates of the scheme was accepted without further comment.

Mr. Illankoon then left the meeting.

5. MINUTES OF THE MEETINGS OF THE ESTATE AND EXPERIMENTAL SUB-COMMITTEE HELD ON NOVEMBER 12, 1951, AND DECEMBER 8, 1951

The Chairman reported that copies of the minutes had been circulated to members who would have noted that consideration of the St. Coombs Estate estimates was the chief business of the latter meeting.

The minutes of the two meetings were accepted without comment.

6. VISITING AGENT'S REPORT OF OCTOBER 10, 1951

The Board accepted the Visiting Agent's report of October 10, 1951, copies of which had been issued to members under cover of circular A12/51 of November 15, 1951.

7. FINANCE

The Chairman stated that all items relating to Finance had been very fully considered by the Finance Sub-Committee in the morning.

(*a*) Accounts for period ending October 30, 1951

The Chairman said that members would be glad to note that the St. Coombs Estate Account had shown a profit of Rs. 26,306·18 at the end of October and commented on the improved condition of the estate as a whole. The total crop harvested to end October was 205,735 lb. against 116,060 lb. at same date last year. It was estimated that the yield for the year would be in the region of 900 lb. per acre.

(*b*) Estate Estimates for 1952

Mr. W. Neal de Alwis proposed and Mr. Errol Jayawickreme seconded the acceptance, of the St. Coombs Estate estimates for 1952. Carried.

(*c*) **Research Estimates for 1952**

Mr. R. C. L. Notley proposed that the Research estimates be approved. Mr. V. G. W. Ratnayake seconded the proposal which was carried unanimously.

8. LOW-COUNTRY SUB-STATION

The Chairman informed the meeting that the agreement between the Kalutara Rubber Co. Ltd., and the Board of the Tea Research Institute relating to the use of the road through Pembroke Estate was due for signing at 4 p.m. He made the following proposal which was unanimously approved :—

> " Resolved that the agreement between the Kalutara Rubber Company of Ceylon. Ltd., and the Board in regard to the use by the Board of the roads through Pembroke estate leading to the bungalow and the right to draw water and to lay water pipe lines and electric transmission lines (which was prepared by the solicitors of the Board) be and is hereby approved and that the Seal of the Board be affixed to the said agreement in the presence of the Chairman, Mr. R. C. Scott, C.B.E., the Director, Mr. J. Lamb, and Mr. R. C. L. Notley, a member of the Board.".

The meeting was then adjourned for the signing of the agreement.

9. ANNUAL REPORT OF THE BOARD FOR 1950

The Chairman said copies of the report (in draft form) had been issued to members. He thought it covered very fully the activities of the Board for 1950. The report was approved without comment.

10. STAFF

(*a*) **Mr. J. Lamb—Director**

An invitation to visit the Tea Research Institute of East Africa had been extended to Mr. Lamb and it was suggested that he should fly to East Africa in early March, spend 2–3 weeks in Africa and complete the journey to the United Kingdom by air. Arrangements have been made for Mr. Lamb to return to Ceylon by sea in May before Mr. Portsmouth was due to commence his leave.

The Board authorised the Director's visit to Africa.

(*b*) **Mr. C. A. Loos**

The Chairman reported that Mr. Loos was due under the terms of his scholarship to commence duties at Rothamsted on April 1, 1952.

(*c*) **Mr. B. N. Webster—Mycologist**

The Chairman reported that Mr. B. N. Webster had since his appointment gained some valuable experience under the general supervision of Dr. S. P. Wiltshire, Director of the Commonwealth Bureau of Mycology. He had spent several weeks at various research centres including East Malling, Long Ashton, Rothamsted and Cambridge.

Mr. Webster was due to arrive in Ceylon on December 25.

(*d*) **Dr. W. J. Dowson**

The Chairman reported that Mr. Lamb had visited Cambridge where he met Dr. Dowson and Prof. Brooks. Dr. Dowson was agreeable to come out to Ceylon for two months in June/August, 1952, to help and advise Mr. Webster and also generally to advise the Director on the programme of pathological research.

Members were all agreed that the proposed visit of Dr. Dowson would be of the greatest benefit to the Institute and approved the terms and conditions under which he was to come out to Ceylon.,

10. ANY OTHER BUSINESS

(*a*) **Junior Staff Provident Fund**

In accordance with the wishes of the Auditors as expressed in their report on the accounts for 1950, it was proposed that the payment of the sum of Rs. 27,600·04 being amount paid to members so as to bring up to 15 per cent. the Institute's contributions on salaries earned from the commencement of the 11th year of service, should be minuted. Agreed.

Tea Research Institute of Ceylon,
St. Coombs,
Talawakelle, February 19, 1952.

J. LAMB,
Secretary.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT 10 A.M. ON SATURDAY, MARCH 1, 1952, AT THE TEA RESEARCH INSTITUTE, ST. COOMBS, TALAWAKELLE

Present.—Mr. R. C. Scott, C.B.E. (Chairman) ; Dr. A. W. R. Joachim, M.B.E. (Director of Agriculture) ; Mr. R. C. L. Notley (Chairman, Planters' Association of Ceylon) : Messrs. W. Neal de Alwis, J.P., U.M., V. G. W. Ratnayake, M.B.E., M.P., D. E. Hettiarachchi, J.P., U.M., H. de T. Wilkinson Kay, Errol Jayawickreme, A. D. McLeod, W. H. Attfield and J. Lamb (Director and Secretary to the Board).

1. NOTICE CONVENING THE MEETING WAS READ

Before taking up the business of the meeting the Chairman moved a vote of condolence with the Royal Family on the death of the late King, His Majesty King George VI.

Letters and messages regretting inability to be present were received from Messrs. A. G. Ranasinha, C.M.G., C.B.E., C.C.S. (Secretary to the Treasury), G. K. Newton and W. H. Gourlay.

2. THE MINUTES OF THE MEETING OF THE BOARD HELD ON DECEMBER 21, 1951, WERE CONFIRMED

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

(*a*) Board

The Chairman reported that :

(i) Mr. R. M. Macintyre had resigned his seat on the Board as a representative of the Agency Section of the Planters' Association of Ceylon as from January 31, 1952. He had since proceeded on furlough. Mr. G. K. Newton had been nominated to take his place with effect from February 22, 1952.

(ii) Mr. W. H. Gourlay replaced Mr. Roger Davies as an ex-officio member of the Board on being elected Chairman of the Agency Section of the Planters' Association of Ceylon on February 22, 1952.

On behalf of the Board he thanked the retiring members for the services rendered to the Institute during the period of their membership. He also extended a welcome to the two new members, Messrs. G. K. Newton and W. H. Gourlay, both of whom had previously served on the Board.

(*b*) Estate and Experimental Sub-Committee

(i) *Visiting Agent, St. Coombs Estate.*—The Chairman referred to the sudden death, which took place on January 17, 1952, of Mr. A. H. Hall, the Visiting Agent of St. Coombs, and a member of the Estate and Experimental Sub-Committee.

The meeting passed a vote of condolence in the customary manner.

The Chairman then reported that the Estate and Experimental Sub-Committee at a meeting held on February 23, 1952, decided to recommend the appointment of Mr. G. K. Newton as the Visiting Agent of St. Coombs. Mr. Newton was agreeable to serve in that capacity.

The Chairman stated that if the appointment was confirmed, Mr. Newton's presence at Board meetings would be of great advantage.

The Board agreed to Mr. Newton's appointment as the Visiting Agent of St. Coombs Estate.

(ii) The Chairman reported that Mr. Richard Leaning of Diyagama Estate had accepted the invitation extended to him and was now a member of the Sub-Committee.

4. FINANCE

(*a*) Accounts of the Institute for period ending November 30, 1951

The Chairman said that copies of these accounts had been issued to members. The St. Coombs estate working account showed a credit balance of Rs. 32,263·26. At the same date in the previous year, the estate had showed a loss of Rs. 26,077·91. It was anticipated that when the final accounts for the year 1951 were closed, the profit from St. Coombs would be in the region of Rs. 68,000. Members would be interested to know that the crop harvested for the year 1951, viz. 265,146 lb., was the highest recorded on St. Coombs. The average yield per acre was 925 lb. The estimated crop was 220,000 lb.

5. STAFF

(i) *Director—Mr. J. Lamb.*—Mr. Lamb was due to leave Ceylon on March 5. He would fly to Kenya to attend the formal opening of the Tea Research Institute there and then proceed to England to complete the balance of his leave. He is due back in Ceylon about May 20, 1952.

(ii) *Plant Physiologist—Mr. G. B. Portsmouth.*—Mr. Portsmouth was due 8 months leave at the end of May, 1952, and his agreement was due for renewal. Mr. Portsmouth was willing to renew the agreement.

The Board approved the leave and renewal of Mr. Portsmouth's agreement.

(iii) *Pathologist—Mr. C. A. Loos.*—Arrangements had been made for Mr. Loos to proceed to the United Kingdom for training at Rothamsted lasting about six months under the Commonwealth Technical Assistance Scheme. He was due to sail on April 24, 1952.

(iv) *Mycologist—Mr. B. N. Webster.*—Mr. Webster arrived in Ceylon on December 25, 1951, and assumed duties at St. Coombs from the New Year.

(v) *Assistant Pathologist—Mr. G. D. Austin.*—Mr. Austin was now 56 years of age and was due for retirement. The Director recommended the extension of Mr. Austin's period of service up to 60 years of age. Mr. Austin was agreeable to the extension and was in possession of a medical certificate testifying to his fitness.

The meeting approved the recommendation and were of opinion that steps should be taken to train an understudy to take Mr. Austin's place when he eventually retired.

6. SMALL HOLDINGS ADVISORY SERVICE

The Chairman reported that a meeting of the Small Holdings Sub-Committee was held last afternoon. Ten candidates selected from a total of 61 applicants were interviewed for appointment as Tea Instructors (2nd batch of five).

The undermentioned Tea Instructors, who were appointed in the first batch, assumed duties as from January 1, 1952 :—Messrs. D. J. Kulatunge, P. Navaratne, G. A. Mendis, T. B. Ratnayake and S. Abeyawickreme.

The Committee had also considered very fully the question of further expansion of the scheme, and in view of the heavy working costs decided to recommend that the appointment of the 3rd batch of 5 Tea Instructors be deferred. They had agreed that if this step was taken the scheme would support itself for at least another 14 years or so. They also agreed to recommend that for the present the additional appointments be restricted to one mechanic/operator and one driver for the propaganda van and a gardener.

On the proposal of Mr. Errol Jayawickreme which was seconded by Mr. A. D. McLeod, the Board unanimously approved the recommendations made and the action taken by the Sub-Committee.

Talawakelle, April 25, 1952.

J. LAMB,
Secretary.

Rubber Research Institute of Ceylon

MINUTES OF THE ONE HUNDRED AND ELEVENTH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON TUESDAY, JANUARY 15, 1952

Present.—Mr. W. A. Paterson (in the Chair); Dr. A. W. R. Joachim (Director of Agriculture); Mr. R. J. Hartley, Mr. F. A. Obeyesekera, Senator C. Wijesinghe and Dr. H. E. Young (Director R. R. I. C.)

An apology for absence was received from Mr. J. L. D. Peiris.

1. MINUTES

(*a*) **Confirmation**

Draft minutes of the meeting held on November 5, 1951, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) **Matters arising from the minutes**

(1) *Salaries and Terms of Service of Staff.*—Revised salary scales and terms of service as recommended by the Director were approved and it was noted that they were in line with those of the Tea Research Institute.

(2) *Reserves and Equipment.*—Lists of additional equipment required for the Chemical and Mycological Departments were tabled and their purchase was approved.

(3) *Representation on London Advisory Committee for Rubber Research (Ceylon and Malaya)*—It was agreed to recommend the renomination of Mr. E. W. Whitelaw for 1952.

2. BOARD

The Chairman reported that Major Montague Jayewickrema, M.P., had been renominated to represent the House of Representatives for a period of three years with effect from February 1, 1952, or for such period as he remains a member of the House of Representatives, whichever is the shorter.

3. REPORTS AND ACCOUNTS

(*a*) Receipts and Payments Account for the 3rd quarter 1951 was approved.

(*b*) Supplementary votes amounting to Rs. 5,385·52 were passed.

4. STAFF

(*a*) *Director.*—Agreed that Dr. H. E. Young, Director, should take three months' leave out of the island about the end of March 1952. Acting arrangements suggested by the Director were approved.

(*b*) *Mycologist.*—Reported that Mr. J. H. Van Emden had arrived in Ceylon and assumed duties as Mycologist and Oidium Research Officer on December 8, 1951.

(*c*) *Junior Staff.*—Changes in staff since the last meeting were reported.

(*d*) *Holidays.*—Consequent on the changes in public holidays announced by Government, the holidays to be observed by the Institute were defined.

5. LIAISON BETWEEN FAR EASTERN UNITS—CONFERENCE TO BE HELD IN 1952

It was agreed that the Director should attend the Conference of Directors and Scientific Officers of Research Stations in the East to be held in Indonesia towards the middle of 1952.

6. LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

Minutes of the 54th meetings of the Committee and the Technical Sub-Committee were tabled.

C. D. De FONSEKA,
Secretary-Accountant.

February 6, 1952.

MINUTES OF THE ONE HUNDRED AND TWELFTH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON MONDAY, MARCH 10, 1952

Present—Mr. W. A. Paterson, J.P. (in the Chair); Mr. W. P. H. Dias, J.P.; Mr. R. J. Hartley; Gate Muhandiram A. D. S. Jayasinghe ; Mr. W. Herbert de Silva; Mr. R. H. Wickremesinghe, C. C. S. (Controller of Establishments); Senator C. Wijesinghe and Dr. H. E. Young (Director, R.R.I.C.)

Apologies for absence were received from Dr. A. W. R. Joachim (Director of Agriculture) and Major M. Jayewickreme, M.P.

1. BOARD

The Chairman reported that—

(*a*) Mr. W. P. H. Dias, J.P., and Mr. W. Herbert de Silva had been nominated to represent the Low-Country Products Association for three years from January 21, 1952, in place of Messrs. J. L. D. Peiris and Francis Amarasuriya.

(*b*) Gate Muhandiram Arthur D. S. Jayasinghe had been nominated by the Hon'ble the Minister of Agriculture and Lands to represent the smallholders for three years from February 1, 1952, in place of Mr. F. A. Obeyesekera.

The new members were welcomed to the Board. In proposing a vote of thanks to the retiring members the Chairman made special reference to the valuable services rendered by Mr. Obeyesekera who had been a member since July 1931. The vote of thanks was seconded by Mr. Hartley and carried unanimously.

Mr. Hartley mentioned that he would be away from the island for six months from April 14, 1952, and it was agreed that he be given leave of absence for this period.

2. MINUTES

(*a*) Confirmation

Draft minutes of the meeting held on January 15, 1952, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) Matters arising from the minutes

(1) *New Salary Scales*—Details of the conversion of salaries to the new scales were approved.

(2) *Reserves and Equipment*—Estimates of equipment and other capital requirements of the estate department amounting to a total cost of Rs. 290,000 were considered and approved.

(3) *Contribution to the British Rubber Producers' Research Association*—Agreed that an annual contribution be offered to Government from the Institute's funds for making up whatever sum the Government may decide to contribute.

(4) *Conference of Scientific Officers in the East*—Agreed that the Director and the Chemist should attend the Conference to be held at Bogor, Indonesia, in July, 1952.

3. REPORTS AND ACCOUNTS

(*a*) *Annual Report for 1951*—The Chairman congratulated the Director on the full and complete activities of the Institute set out in the report and on its prompt preparation. The report was approved and it was agreed that it should be printed together with the Balance Sheet and Auditor's Report for 1950.

(*b*) *Visiting Agent's Report*—was approved.

(*c*) *Visiting Engineer's Report*—was approved.

(*d*) *Statement of Receipts and Payments for the 4th Quarter, 1951*—was approved.

(*e*) *Estate Accounts July to November 1951*—were tabled.

(*f*) *Supplementary Votes*—A supplementary vote was passed for the construction of a greenhouse at Dartonfield for the use of the Mycological Department.

In this connection a member mentioned a discussion at the last meeting of the Kalutara District Planters' Association regarding the appointment of an Oidium Research Officer. It was agreed that the Chairman K. P. A. be informed that there is at present a full time Oidium Research Officer and Mycologist on the Institute's staff.

4. STAFF

(*a*) *Changes in staff*—Changes in staff since the last meeting were reported.

(*b*) *Retiring age*—The retiring age for the Institute's staff was fixed as follows :—

Optional at age 55.
Compulsory at age 60.

(*c*) *Opening of Staff Club House*—The Chairman announced that the Staff Club House at Dartonfield would be formally opened at 4.30 p.m. on Sunday, March 23, and invited members to be present.

5. RUBBER CO-OPERATIVE SOCIETIES

A letter from the Permanent Secretary to the Ministry of Food and Co-operative Undertakings stating that action would be taken to expedite the registration of certain rubber Co-operative Societies was tabled.

6. PUBLICATIONS

The following publications were tabled :—

Advisory Circular No. 31—Root disease in replanted areas.
Advisory Circular No. 32—Crown budding for Oidium resistance.

7. SULPHUR FOR DUSTING PURPOSES

Action taken to obtain adequate supplies of sulphur for the next dusting season was reported and it was noted that two local firms were taking an interest in setting up plant to grind and prepare crude sulphur to the required specifications.

8. PRESS REPORT

An incorrect and unauthorised press report regarding the composition of the Board was brought to the notice of the Board and it was noted that the attention of the papers concerned had been drawn to the inaccuracies.

The meeting terminated at 4.27 p.m. with a vote of thanks to the Chair.

C. D. De FONSEKA,
Secretary-Accountant.

April 3, 1952.

RETURNS, &c.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED 30TH NOVEMBER, 1951

Province	Disease	Fresh cases during the month	Total number from the beginning of this calendar year to November 30, 1951				Balance ill at end of month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	12	90	—	—	85	5
	Rabies	1	7	6	1	—	—
Colombo Municipality	Foot-and-mouth	—	90	—	—	90	—
	Anthrax	—	7	7	—	—	—
	Tuberculosis	—	11	11	—	—	—
	Piroplasmosis	—	6	6	—	—	—
	Haemorrhagic Septicaemia	—	1	1	—	—	—
	Rabies	4	61	61	—	—	—
	Surra	1	1	—	—	1	—
Quarantine Station	Piroplasmosis	—	3	3	—	—	—
	Anthrax (in sheep and goats)	2	58	58	—	—	—
	Pleuro-pneumonia	10	136	136	—	—	—
Northern Province	Pleuro-pneumonia	—	38	38	—	—	—
	Anthrax	—	6	6	—	—	—
	Foot-and-mouth	1	335	—	1	334	—
	Black quarter	265	1,385	1,385	—	—	—
	Rabies	—	14	—	14	—	—
North-Central Province	Foot-and-mouth	446	1,658	5	—	1,207	446
	Black quarter	—	68	68	—	—	—
North-Western Province	Rabies	—	2	—	2	—	—
	Foot-and-mouth	69	118	12	—	97	9
	Black quarter	—	3	3	—	—	—
Central Province	Mange (cattle)	25	286	22	—	240	24
	Foot-and-mouth	252	600	4	—	347	249
	Piroplasmosis	—	2	—	—	2	—
	Black quarter	—	14	14	—	—	—
Province of Sabaragamuwa	Rabies	1	8	1	7	—	—
	Anaplasmosis	—	1	—	—	1	—
Province of Uva	Black quarter	—	11	11	—	—	—
	Rabies	1	12	6	6	—	—
Eastern Province	Rabies	—	5	1	4	—	—
	Foot-and-mouth	22	41	1	—	28	12
Southern Province	Anaplasmosis	—	1	—	—	1	—
	Rabies	—	8	—	8	—	—

Department of Agriculture,
Peradeniya, CEYLON,
January 20, 1952.

T. M. Z. MAHAMOOTH, M.R.C.V.S.,
Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED DECEMBER 31, 1951

Province	Disease	Fresh cases during the month	Total number from the beginning of this calendar year to December 31, 1951				Balance ill at end of month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	90	—	—	90	—
	Rabies	2	9	6	3	—	—
Colombo Municipality	Foot-and-mouth	—	90	—	—	90	—
	Anthrax	—	7	7	—	—	—
	Tuberculosis	1	12	12	—	—	—
	Piroplasmosis	—	6	6	—	—	—
	Haemorrhagic Septicaemia	—	1	1	—	—	—
	Rabies	4	65	65	—	—	—
	Surra	—	1	—	—	1	—
Quarantine Station	Piroplasmosis	—	3	3	—	—	—
	Anthrax (in sheep and goats)	8	66	66	—	—	—
	Pleuro-pneumonia	52	188	188	—	—	—
Northern Province	Pleuro-pneumonia	—	38	38	—	—	—
	Rabies	—	14	—	14	—	—
	Anthrax	—	6	6	—	—	—
	Foot-and-mouth	—	335	—	1	334	—
	Black quarter	96	1,481	1,481	—	—	—
North-Central Province	Foot-and-mouth	234	1,892	7	—	1,482	403
	Black quarter	—	68	68	—	—	—
North-Western Province	Rabies	—	2	—	2	—	—
	Foot-and-mouth	59	177	12	—	106	59
	Black quarter	—	3	3	—	—	—
Central Province	Mange (cattle)	26	312	24	—	264	24
	Foot-and-mouth	315	915	6	—	596	313
	Piroplasmosis	—	2	—	—	2	—
	Black quarter	—	14	14	—	—	—
Province of Sabaragamuwa	Rabies	1	9	1	8	—	—
	Anaplasmosis	—	1	—	—	1	—
Province of Uva	Black quarter	—	11	11	—	—	—
	Rabies	—	12	6	6	—	—
Eastern Province	Rabies	—	5	1	4	—	—
	Foot-and-mouth	3	44	1	—	40	3
Southern Province	Anaplasmosis	—	1	—	—	1	—
	Rabies	1	9	—	9	—	—

Department of Agriculture,
Peradeniya, CEYLON,
January 30, 1952.

T. M. Z. MAHAMOOTH, M.R.C.V.S.,
Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED JANUARY 31, 1952

Province	Disease	Fresh cases during the month	Total number from the beginning of this calendar year to January 31, 1952				Balance ill at end of month
			Cases	Deaths	Shot	Recoveries	
Western Province ..		—	—	—	—	—	—
Colombo Municipality	Foot-and-mouth	28	28	—	—	—	28
	Rabies	7	7	7	—	—	—
Quarantine Station	Anthrax (in sheep and goats)	2	2	2	—	—	—
	Pleuro-Pneumonia	6	6	6	—	—	—
Northern Province	Anthrax	95	95	95	—	—	—
North-Central Province	Foot-and-Mouth	1,015	1,015	22	—	536	457
North-Western Province	Foot-and-mouth	380	380	—	—	—	380
	Rabies	1	1	1	—	—	—
Central Province	Mange (cattle)	50	50	4	—	—	46
	Foot-and-mouth	74	74	—	—	—	74
Province of Sabaragamuwa	Foot-and-mouth	61	61	4	—	24	33
	Amapasmosis	3	3	1	—	1	1
Province of Uva ..		—	—	—	—	—	—
Eastern Province ..	Foot-and-mouth	45	45	—	—	5	40
Southern Province ..		—	—	—	—	—	—

Department of Agriculture,
Peradeniya, CEYLON,
March 18, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED FEBRUARY 29, 1952

Province	Disease	Fresh cases during the month	Total number from the beginning of this calendar year to February 29, 1952				Balance ill at end of month
			Cases	Deaths	Shot	Recoveries	
Western Province ..	Foot-and-mouth	23	23	—	—	19	4
Colombo Municipality	Foot-and-mouth	104	132	—	—	28	104
	Rabies	6	13	13	—	—	—
Quarantine Station	Anthrax (in sheep and goats)	—	2	2	—	—	—
	Pleuro-Pneumonia	40	46	46	—	—	—
Northern Province ..	Anthrax	12	107	107	—	—	—
North-Central Province ..	Foot-and-mouth	—	1,015	22	—	740	253
North-Western Province	Foot-and-mouth	186	566	18	—	353	195
	Rabies	—	1	1	—	—	—
	Anthrax	16	16	16	—	—	—
Central Province	Mange (cattle)	82	132	6	—	49	77
	Foot-and-mouth	250	324	—	—	74	250
Province of Sabaragamuwa	Foot-and-mouth	153	214	21	—	158	35
	Anaplasmosis	—	3	1	—	1	1
Province of Uva ..		—	—	—	—	—	—
Eastern Province ..	Foot-and-mouth	5	50	—	—	35	15
Southern Province ..		—	—	—	—	—	—

Department of Agriculture,
Peradeniya, CEYLON,
April 9, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, DECEMBER, 1951

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Anuradhapura	84·0	+1·0	70·8	+0·7	75	95	4·6	2·55	11	— 4·97
Badulla	76·2	—0·4	64·1	—0·4	82	94	6·5	13·10	20	+ 1·87
Batticaloa	82·8	+1·0	74·1	+0·5	80	93	5·7	14·09	21	— 2·90
Colombo	86·1	+0·6	72·2	—0·1	72	90	5·0	5·88	7	+ 0·27
Diyatalawa	72·3	+0·3	58·4	—0·2	84	97	6·9	6·94	19	— 1·13
Galle	85·2	+1·7	73·4	+0·1	74	90	4·8	2·42	9	— 5·40
Hambantota	85·9	+1·4	73·8	+0·8	75	88	6·0	4·13	11	— 1·48
Jaffna	83·7	+1·3	73·9	+0·9	71	84	4·5	4·38	7	— 6·01
Kandy	82·2	—0·8	66·4	—0·9	74	92	6·0	5·53	14	— 2·91
Kankesanturai	83·6	—	75·0	—	71	79	5·0	6·05	8	—
Kurunegala	85·5	—0·3	70·9	+0·2	70	87	4·6	2·46	13	— 4·32
Mannar	83·8	+1·1	75·7	+0·9	74	82	5·0	2·86	8	— 4·93
Nuwara Eliya	67·3	—0·3	49·0	+0·1	78	90	6·2	6·44	11	— 1·37
Puttalam	85·3	+0·6	71·1	—0·1	73	93	4·7	3·37	8	— 2·18
Ratmalana	86·8	—	71·2	—	68	88	5·6	4·07	9	— 2·58
Ratnapura	89·3	+1·5	71·1	—0·6	70	90	6·4	2·62	11	— 6·50
Talawakele	74·0	+0·5	55·2	—0·9	74	90	3·9	1·92	12	— 3·26
Trincomalee	82·0	+1·0	75·4	+0·7	77	84	5·6	7·08	15	— 5·92

WEATHER SUMMARY, DECEMBER, 1951

Although north-east monsoon conditions prevailed over the Island in December, the weather was predominantly dry during the first half of the month. From about the 17th the north-eastern parts started experiencing wet weather which continued till the end of the month. During this period some stations on the north-eastern slopes of the hills recorded moderately heavy rain almost every day.

On account of a low pressure wave in the Arabian Sea, conditions became unsettled about the 25th and continued so till the 28th. During this period the rain fall became widespread over the Island, being unusually heavy on the 28th. Several stations on the north-eastern slopes of the hills recorded falls over 5 inches on this day. As a result of these persistent rains, eath-slips occurred at several places up-country, while floods were experienced in Batticaloa District and neighbourhood during the last few days.

During December the centre of heavy rain shifted over to the north-eastern slopes of the hills where Nitre Cave region received over 50 inches, St. Martin's (Lower) Estate recording 51·94 inches and St. Martin's (Upper) and Hendon Estates recording 50·67 inches each. Other outstanding totals for the month were 47·13 inches at Iddumekelle Estate, 40·05 inches at Lugaloya Estate, 39·60 inches at Dooroomadella Estate and 38·84 inches at Forest Hill Estate. There was, however, a rapid decrease in rainfall towards the north-eastern low-country, where the larger totals (which occurred in Batticaloa District) were only of the order of 10 to 15 inches. Outside the north-eastern parts the rainfall was mainly below 5 inches.

The bigger excesses (of the order of 10 to 15 inches) also occurred on the north-eastern slopes of the hills, the biggest excesses being 21·81 inches at Iddumekelle Estate, 19·21 inches at St. Martin's (Lower) Estate, 15·80 inches at Meeriatenne Estate, 14·53 inches at Teripehe and 14·09 inches at Madugoda. Outside the north-eastern hill country the rainfall was generally below normal, the greater deficits (of the order 5 to 10 inches) occurring inland in the south-west quarter and in Trincomalee District and neighbourhood. The biggest deficits were 14·78 inches at Millawa, 11·74 inches at Valaichenai, 10·50 inches at Kebitigollewa and 9·87 inches at Nedunkeni.

There were 43 daily falls of 5 inches or over in December, nearly half of them occurring on the 28th. The highest were 10·29 inches at Teripehe and 9·65 inches at Panawa, both on the 28th.

Day temperatures have been appreciably above normal, except in the hill country. Although night temperatures have not deviated much from average, some unusually low minimum temperatures were recorded at a few stations from 9th to 13th. Among these may be mentioned 64·0° at Ratnapura on the 11th, which, in addition to being the lowest temperature for a low-country station during December, was the lowest temperature recorded at Ratnapura in 1951. Similarly, 66·3° at Colombo on the 11th and 44·4° at Talawakele on the 10th were the lowest temperatures at these stations for 1951. The highest temperature for December was also recorded at Ratnapura, viz., 92·9° on the 11th. The lowest temperature was 38·2° at Nuwara Eliya on the 10th. The mean day humidity varied from 70 to 85% and the mean night humidity from 80 to 95%. The skies were more cloudy than usual, particularly on the east side. The wind was above the average strength, the prevailing direction being north-easterly.

D. T. E. DASSANAYAKE,
Director.

METEOROLOGICAL REPORT, JANUARY, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	82·3	—1·0	71·1	+2·0	79	95	5·7	7·48	17	+ 1·68
Badulla	75·5	—0·7	65·3	+1·6	84	95	6·6	13·40	22	+ 3·08
Batticaloa	81·0	—0·5	74·5	+1·0	84	90	6·4	21·25	17	+ 8·37
Colombo	85·9	—0·6	72·2	+0·4	76	93	6·0	8·09	12	+ 4·13
Diyatalawa	71·6	—0·2	59·5	+2·0	84	91	6·8	8·08	20	+ 1·44
Galle	83·2	—0·6	72·9	0	80	93	5·8	7·16	14	+ 3·28
Hambantota	84·4	—0·6	73·0	+0·4	79	93	5·4	4·67	10	+ 0·67
Jaffna	82·5	—0·5	72·7	+0·7	76	90	5·6	6·07	14	+ 1·66
Kandy	82·6	—0·9	67·7	+0·7	74	90	5·8	8·08	13	+ 1·74
Kankesanturai	82·2	—	75·1	—	78	84	5·8	9·43	13	—
Kurunegala	85·7	—0·8	71·1	+1·3	69	88	4·8	3·21	11	— 1·90
Mannar	82·6	—0·7	75·0	+0·9	79	86	5·5	4·12	11	+ 0·28
Nuwara Eliya	66·9	—0·8	51·3	+4·7	79	91	6·6	9·44	19	+ 2·48
Puttalam	84·5	—1·0	71·2	+1·3	77	95	5·2	4·56	12	+ 1·13
Ratmalana	86·4	—	71·4	—	69	85	—	3·94	12	— 0·21
Ratnapura	88·6	—0·7	71·5	+0·4	74	93	6·8	10·16	15	+ 3·90
Talawakele	73·9	—0·3	57·5	+2·2	74	84	5·6	7·34	13	+ 3·47
Trincomalee	80·0	—0·5	75·7	+0·5	81	82	6·9	18·35	16	+10·04

WEATHER SUMMARY, JANUARY, 1952

The weather over the Island in January was influenced by two low-pressure waves in the Arabian Sea. The first was responsible for the fairly widespread rain during the first nine days, which was unusually heavy on the 2nd and 5th. The heavy rain on the 5th was spread over the whole of the east side extending from Trincomalee southwards, as many as 63 stations recording falls over 5 inches. The other was in evidence from the 22nd to 24th, when the rainfall was again fairly widespread, but much less intense. On account of these heavy rains extensive floods were experienced in Batticaloa District resulting in considerable damage to house and property, while disastrous land-slides occurred in Hewaheta area on the east side of the hills.

During the rest of the month the rainfall was generally scattered, no rain at all being reported from the 11th to 16th. Nights were exceptionally cold on the 14th and 15th, resulting in ground frost at Nuwara Eliya on the 15th, with the minimum temperature at 34·0°, 12° below the average.

Rainfall was heaviest on the north-eastern slopes of the hills and in the southern parts of Batticaloa District where the monthly totals generally exceeded 25 inches. The greatest totals were 48·53 inches at Hendon Estate, 46·98 inches at Iddumekelle Estate, 46·15 inches at St. Martin's (Lower) Estate and 45·57 inches at St. Martin's (Upper) Estate. In the north-eastern low-country the rainfall was of the order of 15 to 20 inches, while in the south-west it varied from 5 to 15 inches. Least rain was experienced in the North-Western Province and in Mannar District, where the monthly totals were below 5 inches.

Greater excesses (of the order of 10 inches) also occurred on the north-eastern slopes of the hills and in the southern parts of Batticaloa District, the outstanding excesses being 26·32 inches at Pottuvil Estate, 19·48 inches at Timitar Estate, 19·45 inches at Iddumekelle Estate and 19·20 inches at Rufuskulam. In the north-eastern and the south-western low-country the excesses were of the order of 5 inches. Deficits were small and were found mainly in the North-Western Province, those at Maha Uswewa and Vicarton Estate being 3·55 and 3·36 inches, respectively.

There were 87 daily falls over 5 inches in January, nearly all of them occurring on the 2nd or 5th. The highest were 12·92 inches at Iddumekelle Estate, 10·87 inches at St. Martin's (Lower) Estate and 10·40 inches at Hendon Estate on the 5th.

Day temperatures were appreciably below normal. Although some very low night temperatures were experienced from the 12th to 16th, the monthly mean minimum temperatures were well above normal, particularly up-country. The highest temperature recorded in January was 93·1° at Ratnapura on the 24th. The lowest temperature for a low-country station was 64·6° on the 14th, recorded both at Kurunegala and at Ratmalana, while the lowest temperature for the whole Island was 34·0° at Nuwara Eliya on the 15th. The mean day humidity varied from 70 to 85% and the mean night humidity from 85 to 95%. The skies were more cloudy than usual. The wind strength was about average, the prevailing direction being north-easterly.

A. P. KANDASAMY,
for Director.

METEOROLOGICAL REPORT, FEBRUARY, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	86·9	—0·1	72·0	+2·6	72	95	5·0	1·31	7	— 0·41
Badulla	79·5	+0·5	64·9	+1·9	76	94	5·6	3·03	10	— 0·14
Batticaloa	83·4	+0·5	75·2	+1·5	80	91	5·2	5·38	10	+ 1·17
Colombo	87·1	—0·1	73·1	+1·0	77	95	5·0	4·58	7	+ 1·98
Diyatalawa	75·8	+1·0	58·7	+2·0	75	91	5·7	5·35	14	+ 2·98
Galle	85·0	—0·2	74·4	+0·7	78	93	5·1	7·19	12	+ 3·90
Hambantota	86·7	+0·8	73·7	+0·7	75	90	5·0	0·63	3	— 0·83
Jaffna	86·2	+0·6	73·9	+1·6	70	90	4·7	1·04	2	— 0·42
Kandy	86·2	—0·5	68·3	+1·4	67	90	5·1	7·09	9	+ 4·78
Kankesanturai	85·3	—	76·4	—	72	82	5·2	0·92	5	—
Kurunegala	90·9	+0·9	71·7	+2·1	61	88	4·6	6·38	7	+ 4·39
Mannar	86·1	0	75·8	+2·1	73	88	5·0	1·39	6	— 0·31
Nuwara Eliya	69·0	—0·5	49·7	+4·8	75	90	5·2	4·62	12	+ 2·63
Puttalam	87·5	—0·8	71·6	+1·4	74	95	4·6	3·39	8	+ 2·02
Ratmalana	86·8	—	72·8	—	73	88	5·4	6·73	8	+ 3·37
Ratnapura	91·8	+0·3	73·1	+1·8	70	95	6·6	6·19	14	+ 0·89
Talawakele	76·1	—0·3	56·6	+2·2	72	85	4·4	4·54	7	—
Trincomalee	82·4	—0·1	77·2	+1·5	77	80	5·6	1·80	10	— 0·85

WEATHER SUMMARY, FEBRUARY, 1952

There were two spells of wet weather in February. The first lasted from 4th to 7th with fairly widespread heavy rain in the southern half of the Island on the 5th and 6th, and the second from 20th to 24th with heavy falls at several stations among and around the central hills from 20th to 23rd. On the 29th too some stations in the hills experienced moderately heavy rain. During the rest of the month the weather was generally warm and dry.

On account of these rains the rainfall was well above normal in the south-western parts and on the north-eastern slopes of the hills, the greatest excesses being 14·23 inches at Oonanagalla Estate, 13·06 inches at Illukkumbura and 12·62 inches at St. Martin's (Lower) Estate. Appreciable excesses were also found in Chilaw and Puttalam Districts. Deficits, generally small, occurred in the north-central parts and in the south-east, the highest being 3·61 inches at Pottuvil Estate and 2·81 inches at Embilipitiya Tank.

Monthly rainfall was mainly of the order of 5 to 10 inches in the south-western parts and in the north-eastern hill-country, larger amounts occurring in Rangala area and scattered in places in the south-west. The biggest totals were 23·13 inches at Hendon Estate, 23·12 inches at St. Martin's (Lower) Estate, 20·34 inches at Illukkumbura and 19·88 inches at St. Martin's (Upper) Estate. Least rain was experienced in the northern and north-central parts and in the south-eastern low-country, where rainfall occurred only on one or two days, the monthly totals being of the order of an inch or so.

There were 22 daily falls over 5 inches in February, a majority of them occurring on the 5th or 6th. The highest was 10·61 inches at Oonanagalla Estate on the 23rd.

Day temperatures have not deviated much from average. The highest temperature recorded in February was 95·0° at Ratnapura on the 22nd. Night temperatures were well above normal, particularly at inland stations. Nights were coldest from 14th to 16th, the lowest temperature recorded at a low-country station being 64·8° at Puttalam on the 15th and the lowest for the whole Island 38·1° at Nuwara Eliya on the 16th. Mean day humidity varied from 65 to 80% and the mean night humidity from 85 to 95%. The skies were more cloudy than usual. The wind was of the average strength, the prevailing direction being north-easterly.

A. P. KANDASAMY,
Acting Director.

METEOROLOGICAL REPORT, MARCH, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·9	+1·7	71·5	—0·1	60	93	2·1	2·79	5	— 1·36
Badulla	82·8	+0·4	64·7	+0·5	69	94	4·2	5·70	9	+ 0·65
Batticaloa	85·5	+0·1	75·6	+0·6	76	91	3·2	1·11	2	— 2·36
Colombo	88·8	+0·8	73·8	—0·2	72	95	4·4	0·26	6	— 4·40
Diyatalawa	78·9	+1·6	58·4	+0·3	68	88	5·2	5·64	14	+ 0·75
Galle	86·0	—0·4	75·8	+0·8	74	88	4·8	4·65	10	— 0·66
Hambantota	87·9	+1·0	74·9	+0·7	72	90	3·8	3·79	4	+ 0·40
Jaffna	89·7	+1·1	75·3	—0·5	64	84	2·1	0·00	0	— 1·58
Kandy	89·3	+0·4	68·1	—0·5	63	92	3·4	4·79	7	— 1·05
Kankesanturai	88·8	—	74·2	—	64	84	2·1	0·00	0	—
Kurunegala	92·8	0	71·7	—0·4	59	90	2·6	1·75	5	— 4·53
Mannar	89·8	+0·5	75·0	—0·2	67	88	2·0	0·00	0	— 1·84
Nuwara Eliya	72·2	+1·4	45·7	—0·6	64	86	4·8	4·19	11	+ 0·10
Puttalam	89·8	—0·1	72·4	—0·5	67	93	2·4	0·31	3	— 2·67
Ratmalana	87·7	—	73·9	—	72	95	4·1	1·92	6	— 4·56
Ratnapura	93·5	+1·5	72·7	+0·2	69	95	5·4	5·88	11	— 4·50
Talawakele	78·5	+0·6	55·0	—0·3	66	78	3·2	5·39	10	+ 0·77
Trincomalee	85·8	+0·4	76·9	+0·5	70	82	2·8	0·13	2	— 2·17

WEATHER SUMMARY, MARCH, 1952

Weather conditions in March were mainly warm and dry. The only period during which fairly widespread rain was experienced was from 15th to 17th, when moderate rain was recorded among and around the central hills and in the North-Central Province. Scattered rain was experienced in the south-west quarter on a few other days, with some appreciable falls on the 28th and 31st. The rainfall was mainly the result of afternoon or evening thunder activity.

The region that registered the highest totals was the Deniyaya Hills, where rainfall was experienced on about 15 days, Beralapanatara aggregating 19·06 inches for the month, Panilkande Estate 18·26 inches, and Figland Estate 18·02 inches. Balangoda and Haputale hills also received appreciable rain, with monthly totals ranging from 10 to 15 inches. Elsewhere in the south-west quarter and among the hills, the rainfall was generally of the order of 5 inches. Outside this region, the rainfall was much less, practically no rain being experienced in the Northern Province and in Trincomalee District.

Rainfall was below normal over most of the Island, bigger deficits, of the order of 5 to 10 inches, occurring in the south-western low and mid-country. The biggest deficits were 8·31 inches at Labugama, 8·10 inches at Rayigam Estate, and 8·06 inches at Indikada. Excesses, generally small, were found among the Deniyaya hills and in the eastern half of the hill-country, the highest being 7·33 inches at Beralapanatara and 6·52 inches at Gourakelle Estate.

There were only two daily falls over 5 inches in March, 6·29 inches at Bundala Lewaya on the 2nd, and 5·60 inches at Hendon Estate on the 31st.

Day temperatures were well above normal, particularly at inland stations, while night temperatures did not deviate much from average. The highest temperature recorded in March was 97·5° at Anuradhapura on the 15th, and the lowest temperature for a low-country station 66·7° at Kurunegala on the 10th, while the lowest temperature for the whole Island was 34·8° at Nuwara Eliya on the 8th. The mean day humidity varied from 60 to 75% and the mean night humidity from 85 to 95%. Cloudy conditions and wind strength were about average.

A. P. KANDASAMY,
Acting Director.

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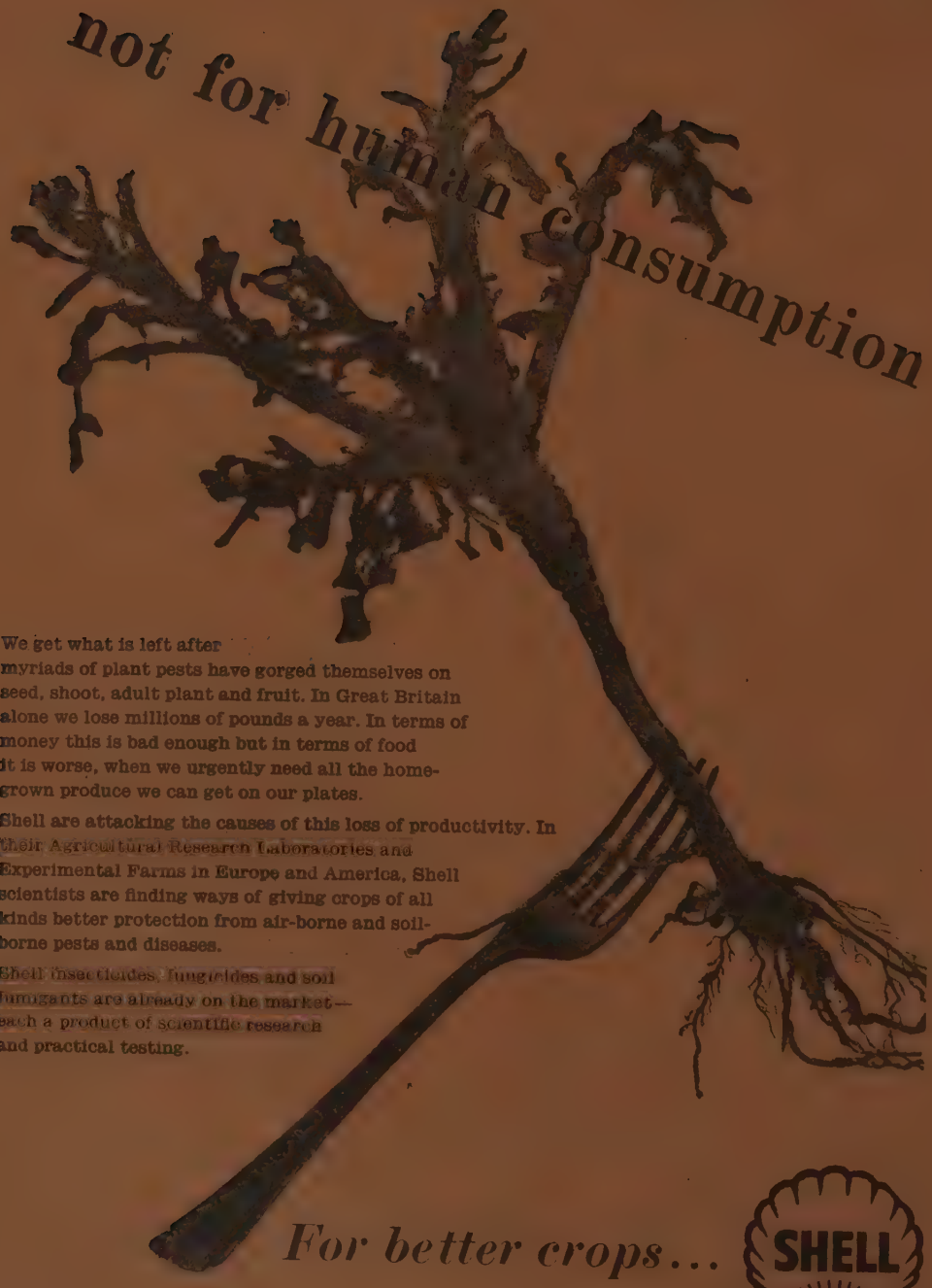

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EDITORIAL

Soil Erosion and Conservation in Ceylon

THE importance of the subject of soil conservation was recognized in Ceylon from early times. Largely as a result of representations made by Dr. G. H. K. Thwaites, Superintendent of the Royal Botanic Gardens, Peradeniya, from 1849 to 1880, who realized the serious consequences of the severe losses of soil that had occurred as a result of the indiscriminate planting of coffee and cinchona and the need for circumspection in the alienation of land for development, the then Colonial Secretary issued an order in 1873 that no land in the Island above 5,000 ft. should be alienated. Soil erosion in the Island has since been the subject of adverse comment by many visiting forestry and agricultural experts, and Commissions and Committees have thoroughly discussed the question from time to time. The last to issue a report on the subject was a Committee appointed by Government in 1930 to study the question of Soil Erosion and make recommendations thereon. Prior to this Committee's appointment, however, the Department of Agriculture under Sir Frank Stockdale had time and again drawn the attention of agriculturists to the seriousness of the problem. Much co-operative work followed as a result, and many of the technical advances in conservation practice, particularly in respect of earthworks and drainage systems, were, in fact, the contributions of practical agriculturists.

In the meantime T. H. Holland and A. W. R. Joachim had completed their five-year (1926–31) soil erosion investigations at the Experiment Station, Peradeniya.* This trial clearly demonstrated the efficacy of cover crops as a soil protector. Endeavours to determine suitable soil covers for the permanent crops followed, and while suitable species have been found for rubber and for coconuts in certain districts, the ideal cover crop for tea has yet to be discovered. Selective weeding has, however, been tried but without much success. A more effective means of soil conservation in tea plantations is the contour planting of tea and this is increasingly being adopted in new clearings on the more progressive estates. The post of Soil Conservation Officer in the Department of Agriculture was created in 1945, though much of the initial work on the subject had been undertaken by W. C. Lester Smith

* A Soil Erosion Experiment Trop. Agri. LXXX, 4, 1933.

while serving in other capacities. E. J. Livera was the first to be appointed to the post in an acting capacity. He carried out observational trials on various types of earth bunds and terraces suitable for conditions of arable cropping.

The appointment in 1949 of Dr. R. M. Gorrie, an officer with wide experience of soil conservation, land use and forestry problems as Soil Conservation Officer was a further milestone in the Island's conservation history. Gorrie's main contribution to the solution of the soil conservation problem in Ceylon was two-fold : he was largely responsible for the technical provisions of the Ceylon Soil Conservation Act of 1951, the contents and an appraisal of which appear in this issue of *The Tropical Agriculturist ;* he also developed the concept of soil conservation as a corollary to water conservation under a system of proper land use. With the assistance of a limited staff he has undertaken, among others, land use surveys of the Gal Oya Catchment and of certain villages in the Kotmale landslip area as a basis for sound conservation practice. This concept of proper land use found full expression in the discussions of the Tropical Land Utilization Conference held in Nuwara Eliya in September 1951 under the auspices of the Food and Agricultural Organization. An important recommendation of this Conference closely affecting the organization of soil conservation measures in a country was that the catchment areas of streams should be the natural units for land development in order that the utilization and control of the water and land on such units may be of greatest advantage. Any future land development policy to be formulated for Ceylon, with which will closely be associated any soil conservation policy, would no doubt take cognizance of this fundamental recommendation.

Closely associated with any land development policy should be a sound national forestry policy. It is axiomatic that good and permanent agriculture depends on good and permanent forestry. History affords us many instances of the failure of civilizations through the wanton destruction of forests, and no doubt these salutary examples will serve as a warning to those countries which have in the past either through neglect or for purposes of exploitation adopted such a policy.

The provisions of the Ceylon Soil Conservation Act are of a comprehensive nature and relate to all the factors responsible for the destruction and deterioration of our soils. In order, however, to control the ravages of soil erosion in areas which need most attention, the Ordinance provides for these to be declared " erodible areas " and special regulations will be framed in respect of them. The headwaters of the Mahaweli and Kelani rivers are to be given priority of treatment as " erodible areas ". Regulations under the Act have been framed in regard to one of them, and these now await the sanction of Parliament. Thereafter will begin, though in a modest way to start with, a national drive for the conservation of the Island's most important asset, its soil. With the experience gained in the operation of the Act and the building up of a suitably-trained staff, the Island can hope in the not too distant future to conserve for posterity what little, in some areas, has been left of this vital natural resource. In this battle for the soil, whether in relation to large estates and plantations or to small holdings, all our

agricultural forces will have to be mustered in full strength and active co-operation. It is the small holding, unfortunately, which will need our closest attention though, examples of land misuse have not been restricted to this agricultural category only. In fairness to the more progressive plantations, it has to be stated that they have not been oblivious to the pressing need for adopting good soil conservation practices on their properties, and many of them are quite prepared to go to any length to see that their most permanent asset is adequately conserved.

It is to the credit of our present Government, and particularly to Mr. Dudley Senanayake, the former Minister of Agriculture and Lands, that they have taken a bold step to give expression to the proposition that " the care of the land is a pre-requisite to survival ", by the enactment of our Soil Conservation Act.

ORIGINAL ARTICLES

The Soil Conservation Act, No. 25 of 1951

BY

R. MACLAGAN GORRIE

THE substance of this new Act is reproduced in full below together with some comments on how it is being put into action and what results are hoped from it :—

Act to make provision for the Conservation of Soil Resources, for the Prevention or Mitigation of Soil Erosion and for the Protection of Land against damage by Floods and Drought

[*Date of Assent : August 13, 1951.*]

BE it enacted by the King's Most Excellent Majesty, by and with the advice and consent of the Senate and the House of Representatives of Ceylon in this present Parliament assembled, and by the authority of the same, as follows :—

Short title.

1. This Act may be cited as the Soil Conservation Act, No. 25 of 1951.

Surveys and investigations as to nature and extent of soil erosion.

2. (1) It shall be the duty of the Director to cause surveys and investigations to be made for the purposes of ascertaining the nature and extent of soil erosion and of damage to land by floods and droughts, and of enabling the Minister to determine the areas which should be declared under this Act to be erodible areas.

(2) For the purposes of any survey or investigation carried out under subsection (1), it shall be lawful for any officer authorised in writing by the Director in that behalf to enter and inspect any land at any reasonable time, together with such other persons as he may require, and to carry out thereon all such examinations and inquiries as may be necessary.

Declaration of erodible areas.

3. The Minister may by Order published in the *Gazette* declare any area defined in the Order to be an erodible area for the purposes of this Act.

Regulations for erodible areas

4. The Minister may make regulations, to be applicable either generally in all erodible areas, or specially in any specified erodible area—

(*a*) requiring the owners of land to make measures designed to prevent or control soil erosion, including measures for the afforestation of sources of streams and of the banks of streams, for the conservation of vegetation along the banks of streams, for the training of streams by means of check dams or otherwise, and for the erection of contour ridges or terraces ;

(*b*) prohibiting or restricting the clean weeding of land or other agricultural practices conducive to soil erosion;

(*c*) restricting the use of land for agricultural or pastoral purposes, where such restriction is necessary for the purpose of preventing or controlling soil erosion or protecting the sources and banks of streams;

(*d*) prohibiting or controlling the exploitation of forest and grass land resources in the interests of soil conservation or for the purpose of reducing the danger of fires or of damage caused thereby;

(*e*) authorising any prescribed officer or person to give directions for seasonal or periodical changes in the type or nature of crops cultivated, or for the adoption or alteration of cultivation practices for the purpose of promoting soil conservation.

Acquisition of land required for carrying out measures to prevent erosion.

5. Where the Minister is satisfied that any land in any erodible area should be withdrawn from cultivation or that any measures designed to prevent or reduce erosion should be taken on or with respect to any such land by the Government, the Minister may declare that the land is needed for a public purpose; and upon such declaration being made, the land shall be acquired under the Land Acquisition Act, No. 9 of 1950, and the provisions of that Act (other than the provisions of sections 2 and 3 thereof) shall apply accordingly.

General regulations.

6. The Minister may make regulations for or in respect of all or any of the following matters :—

(*a*) the measures to be taken by owners of land for the purposes of the preservation and promotion of soil fertility and of facilitating the absorption of moisture by the soil;

(*b*) the measures to be taken by owners of land for the purpose of preventing or reducing or remedying damage by soil erosion;

(*c*) the control of the grazing of animals in so far as grazing interferes with the cultivation of land or is likely to reduce soil fertility or to be conducive to damage by soil erosion;

(*d*) the control of floods and of the effects of drought by means of provision requiring the diversion of water or the storage of water, and the correlation of measures designed to control floods and conserve water with measures taken by local authorities for the purpose;

(*e*) the prohibition or restriction of the burning of grass land and of the spread of fire during the burning of chenas;

(*f*) the specification of the times of tillage and irrigation and of the methods of irrigation in specified areas in order to ensure the economic use of available water;

(*g*) the authorisation of any prescribed officer or person to give directions for seasonal or periodical changes in the type or nature of crops cultivated, or for the adoption or alteration of cultivation practices for the purpose of promoting soil conservation;

(*h*) the cambering and cross-draining of roads and paths under the control of any Government Department or local authority and the prohibition or control of the securing of drains and water-channels ;

(*i*) any matter in this Act stated or required to be prescribed.

Loan to owner of land who is required to take measures under the Act.

7. (1) Where the owner of any land is required by any regulation made under this Act to take any measures upon or with respect to that land, the Director may, if authorised thereto by regulations made in that behalf and subject to such conditions or restrictions as may be prescribed by such regulations, grant a loan to the owner for the purpose of assisting him to defray the cost of such measures.

(2) No loan shall be made under the preceding provisions of this section except out of moneys provided by Parliament for the purpose.

(3) Regulations may be made prescribing the security upon which loans may be granted under this section and the rate of interest payable upon such loans, and providing for the time and manner of the repayment or recovery of the principal and interest due on such loans.

Authority for Director to take measures where owner of land fails so to do.

8. (1) In any case where any owner of any land fails to take on or with respect to the land any measures specified in that behalf in any regulation made under this Act, it shall be lawful for the Director, after giving to the owner notice of such duration as may be prescribed, to cause such measures to be taken on or with respect to that land by an officer authorised in writing by the Director in that behalf ; and it shall be lawful for any officer so authorised to enter the land, together with such other persons as he may require, and to carry out thereon all such work as may be necessary for the purpose of taking the required measures.

(2) The cost of carrying out any work on or with respect to any land in pursuance of the powers conferred by sub-section (1) shall be payable by the owner in such instalments as may be prescribed ; and the amount of any such instalment, if unpaid, shall be recoverable by civil action as a debt due to the Crown.

General provisions as to regulations.

9. (1) Every regulation made by the Minister under this Act shall be brought before the Senate and the House of Representatives for approval, and if so approved shall be published in the *Gazette* and come into operation upon the date of such publication.

(2) Any regulations made under this Act may empower any such officer or person may be specified therein to make such orders or issue such directions to owners of land, cultivators or other persons as may be necessary for securing compliance with or carrying out the objects and purposes of this Act or of any regulations made thereunder.

Appointment of officers.

10. There may be appointed all such officers and servants as may be necessary for carrying out or giving effect to the principles and purposes of this Act.

Offences and penalties.

11. Any person who contravenes or fails to comply with any regulation made under this Act or any order or direction made or given under any such regulation, or who resists or obstructs the Director or any other officer by or under this Act, shall be guilty of an offence and liable on conviction after summary trial before a Magistrate to a fine not exceeding five hundred rupees.

Interpretation.

12. In this Act, unless the context otherwise requires—

" Director " means the Director of Agriculture ;

" Minister " means the Minister of Agriculture and Lands ;

" owner " in relation to any land includes the lessee or usufructuary mortgagee of the land ;

" prescribed " means prescribed by regulation made under this Act.

In framing the Act many foreign statutes were scanned in an effort to find the best precedents. Full use was made of the recently enacted Soil Conservation and River Catchments Act of New Zealand, and of the Punjab " Chos " Act, first drafted in 1903 but drastically revised in 1944. Both of these had more to contribute to Ceylon's requirements than the Soil Conservation Act of the United States whose operation depends so largely upon a majority of the farmers in an area voting to bring themselves under the Act as a district under a voted committee which has very large powers of executive and operational discipline.

All the functions of the Act are vested in the Director of Agriculture who will thus have to enlarge the scope of his department from being purely advisory and educative, as he, through his officers, will now have to undertake new executive and administrative tasks of land management and the regulation and restriction of the uses of land.

Under section 2 of the Act, the Director of Agriculture is empowered to have surveys and investigations made for the purpose of ascertaining the nature and extent of erosion and of damage to land by floods and droughts. The type of survey or reconnaissance authorized under this section of the Act is already in practice as a sort of fact-finding Land Use Survey by an analysis of erosion conditions, slope, soil, cropping methods, ownership, &c.

The skeleton staff so far allocated to the Soil Conservation Officer is employed on such a field to field survey of the Kotmale area of the lower hills to locate landslips and analyse individual holdings to find out which are eroding most, and to prepare plans for such changes in land use as may be found necessary. For instance paddy land with a slope steeper than 1 in 5 is recommended for the stoppage of irrigation and bringing under a non-irrigated annual crop. The justification for this is seen in the increasingly common " soil creep " which is an unfortunate feature of many of the larger and steeper paddy blocks in Kandy and Nuwara Eliya civil districts.

The steeper land under other annual food crops is earmarked for afforestation or planting with cardamoms under a light tree canopy as they constitute one of the best soil holding crops and still give a fair money return.

The Act provides for the advancing of loans to land owners to help them with the construction of stone terracing to improve land on permissible slopes, but the position of the small man who can neither afford a loan nor find acceptable security has yet to be considered.

Interference with current irrigation practices is also authorised by the Act, and it is hoped that by a combination of educational effort and practical demonstration the wasteful misuse of irrigation supplies in hillside paddy lands will be brought under some sort of control. Excessively heavy irrigation is one of the main causes of soil creep and landslip.

The object of sections 3 and 4 is to bring the vitally important river catchments in the high hills under a special protective regime in which owners can be forced to put their land into good order with such accepted erosion control devices as may be considered best for any given crop or condition of land. A start is to be made with the head waters of the Mahaweli and Kelani by applying a set of rules to about 300,000 acres in the tributary valleys of the Maskeliya, Kehelgoma and Kotmale. This will include some 220,000 acres of tea estates, the rest being village lands and forest.

The second type of rule (section 6) is a general regulation which can be applied specifically to one crop throughout the Island—as for instance to coconut or cacao wherever they occur, or to a given set of erosive conditions such as arises through very heavy grazing or through grass fires.

The Act further provides for the acquisition of land as being needed for a public purpose where the Minister is satisfied that any land in a erodible area should be withdrawn from cultivation or where preventive measures are to be taken by Government. It is hoped however that acquisition will seldom be needed and every effort must be made to induce the owners of land to do whatever is needful towards reducing erosion through their own initiative and as part of an improved agriculture. To further this object the Act provides for the issue of loans by Government to such owners as undertake such tasks as the terracing of hillside fields to make them into bench terraces supported on either stone terraces or grassed river banks.

Finally the act provides for a fine not exceeding Rs. 500 for contravention or failure to comply, but a much heavier punishment actually lies in section 8 which gives authority for work left undone by the owner to be done by Government, the cost being recoverable from the owner by civil action as a debt due to the Crown.

Drainage Basin Management

BY

R. MACLAGAN GORRIE

(A paper presented at the United Nations Scientific Conference on the Conservation and Utilization of Resources, Lake Success, 1949)

ABSTRACT

Three essential aims :

1. Preserve plant cover wherever in reasonable condition and ecologically stable ; where cover already deteriorated or naturally inefficient, runoff control needs engineering devices (contouring to aid afforestation, check dams in gullies, complete terracing of ploughland).

2. Deal with the whole of each small catchment as a unit. Sounds obvious but often prevented by administrative difficulties, e.g., smallness of individual holdings interferes with contouring ; consolidation of holdings is lengthy legal routine ; government averse to coerce unwilling owners ; common land is nobody's business : common grazing rights hinder herd reduction ; allotment of funds often cut in emergency ; co-operative organization for improving waste land produces " pepper-pot " scattering of effort ; land revenue (tax) department averse to changes in field boundaries.

3. Control the water and the soil will look after itself.

I shall try to show in this paper how local experience in extreme climates and amongst primitive people may possibly be applied to the more equable climates and more advanced types of farming, particularly by comparing the relative efficiency of soil-moving machinery as compared with the indigenous methods of digging and moving soil.

PRESERVING AND IMPROVING PLANT COVER FOR WATER CONTROL

Under this heading the main activities must obviously fall into two groups (*a*) afforestation and grazing control on the one hand, and (*b*) the water use in plough land on the other. In some topographies it may be feasible to separate these completely so that the forester and the cultivator can each be left to do his own work without interfering with the others but Punjab experience tends to show that in our badly gullied uplands the fringe of down-at-heel lands which has passed, or is passing, out of cultivation makes a most intricate pattern around the head of each small catchment and that once land has reached a badly gullied condition with steep flanks sloping into the local main water channel, economical reclamation is essentially a job for a team. The forester or the farmer alone is equally helpless.

METHOD OF RECLAMATION

Experience has shown that the most profitable way to use Caterpillar bulldozers is to combine them with hand labour. If each cultivator who owns land in a narrow gully or nala bed builds a stout masonry dam, the machines can be used subsequently to build up wing walls and raise the height of the structure, thus giving a bigger field behind and quicker silting and levelling. This type of work will give land of higher crop value than the terracing of the more level plateau land. The forest department is already making subsidies to individual owners towards approved masonry bund projects. Some 15,000 acres of nala-bottom cultivation have been reclaimed by means of masonry bunds, and this reclamation has cost Rs. 80 to 150 per acre. Such nala-bottom dams can only be made safe and permanent if the whole of the catchment above the dam has been brought under a flood control regime, the ploughland being fully terraced and the uncultivated land either afforested or under strict grazing control so that grass lands are kept fully absorptive.

COST OF MACHINE WORKING PER HOUR

All costing figures are based upon (*a*) actuals—consisting of all running expenses plus operator's pay, (*b*) overhead expenses which include writing-off the costs of the machine over 10,000 hours, plus $\frac{1}{2}$ that figure for major repairs, plus interest on capital investment at 4 per cent. For machines at present available all-in costs of D-7 are Rs. 17 per hour and for a D-4 Rs. 9 per hour, and the working charges account for roughly half of each. These figures correspond closely with Caterpillar Company's own published data, which for Punjab conditions are : cost per hour, in rupees (Rs. 13 to £1, or roughly 3 rupees per dollar) :

	D 8	*D 7*	*D 6*	*D 4*	*D 2*
Actual running costs ..	9·22	6·90	6·11	4·74	4·40
Overheads	11·11	8·29	6·25	4·15	3·24
Total ..	20·33	15·19	12·36	8·89	7·64

CASH RECOVERIES

D-7s have only recently become available and the recovery in their case at present is a flat rate of Rs. 14 per hour in cash from the owner of the land. This is very nearly the full cost including interest and depreciation for the D-7 when working alone, though the introduction of a scraper attachment costing Rs. 23,000 pushes up the total to somewhere around Rs. 17 by increasing depreciation and interest charges. Although this Rs. 14 charge puts this machine beyond the reach of the poorer classes of owner, this type of work is exceedingly popular and a very large waiting list of applicants for the use of these machines exists in all districts where the machines have worked.

MACHINE COSTINGS ON AN ACREAGE BASIS

There are so many factors affecting the cost per acre that it is dangerous to give a firm estimate for a given area until some work has been done for these or identical conditions. The main factors affecting cost per acre are :

(1) slope ; see below ;

(2) hardness or toughness of ground surface ;

(3) proximity of rock strata, pebble beds or red marl beds ;

(4) experience of operators, the cost coming down steadily with practice ;

(5) size of individual fields, very small fields being a nuisance for any machine but being worst for the larger machines which have not room to manoeuvre, or if they can do so, they waste fuel in frequent stops and gear changes ;

(6) for nala-bottom reclamation the cost of the bund has to be offset against the acreage of the silted bed behind the bund.

EFFECT OF SLOPE ON COSTS

Over a period of 6 months' work in the deeply gullied plateau lands of the Ojhri Catchment near Rawalpindi, the following data were produced with a D-4 pulling a 5-tine scraper :—

Slope class	*Cost per acre*		
	2nd 3 months	*3rd 3 months*	*Round figure average*
Per cent.			
0–2	102	88	90
2–4	108	102	105
4–6	174	121	150
6–8	192	205	200
Over 8	264	251	250

This shows clearly that costs rise steeply as a function of the slope and above 8 per cent. the cost mounts so quickly that it soon becomes uneconomic to terrace for fields. Somewhere around 8 per cent., therefore, is the margin between reclaiming for fields and for afforestation. Steeper slopes can however be profitably worked by machines to produce a contour ditch and ridge or *gradoni* (Italian for shelf or platform) on which tree or coconut planting or grass cultivation will still pay a good profit through the quicker and better growth which will result as compared with planting on an unimproved slope. (An 8% slope is 1 in 12 or 4 degrees, 34 minutes.)

RECLAMATION AS AN INVESTMENT

To define the position for agricultural land, the above gives a clear indication of the cost for plateau land completely levelled between field boundaries. Unimproved land of this type near Rawalpindi can be purchased for 600 to 800 rupees an acre, so allowing a further Rs. 150 per acre for terracing, and with wheat at its present price, the whole cost can be recovered in the first four wheat harvests.

In the case of more ambitious nala-bottom bunds, which are now becoming so popular with the larger Attock and Mianwali landlords, it pays to build big soil-saving bunds with donkeys and head-loads, so it must obviously pay even better with bull dozers which can do this work cheaper and quicker and can extend the crop area by filling up the torrent bed and breaking down hillocks in the reclaimed area. The cost of such reclamation works out at from 80 to 150 rupees per reclaimed acre.

THE PRINCIPLE OF THE CATCHMENT AS A UNIT

In our anxiety to recover as much as possible of the costs for government it is very easy to be sidetracked away from the principle of the catchment. No matter how successful or popular our land reclamation is proving, it will fail if we do not insist upon each unit catchment being dealt with as completely and as comprehensively as possible for water conservation and flood control. This is the only justification for our thrusting into the reclamation of agricultural land. The endless and ragged fringe of bad cultivation retreating before each advancing gully-head has got to be mastered and it can only be made safe and profitable by adopting every possible type of land use and adapting our machine attack towards easy afforestation, fodder production, village tanks and ponds as well as plough land.

FURTHER DEVELOPMENT

The disadvantage of applying any hard and fast rule for recovery of costs is that it precludes us from attempting further experimental work. The building of dams in broad shallow nalas and the terracing of fields on the easier slopes are safely past the experimental stage and we have a long waiting list of applicants clamouring for the use of our machines on such land. But a great deal of pioneering and experiment still remains to be done on the partial terracing of steeper land for afforestation and on the type of earth dams and masonry escape needed to store floods in the deeper and narrower nalas. To insist upon a cent per cent return of government's investment would, therefore, be a serious mistake. We must be allowed freedom to experiment as and when required in order to make as complete a job as possible of each catchment.

OTHER ADMINISTRATIVE DIFFICULTIES IN APPLYING SOIL CONSERVATION PRINCIPLES

Many other difficulties have arisen in the course of Punjab work and some of them should be of general significance even in more fully developed countries, so short notes are given on the following points :—

(*a*) the smallness of individual holdings and the continued fractionizing due to laws of succession to property interfere with any attempt at scientific contouring through rendering the shape and size of each field awkward for terracing and even in extreme cases too small for the use of a plough.

(*b*) one answer is in the consolidation of holdings but this is a lengthy legal routine which takes some years to make operative through a separate branch of the civil administration which deals with it. The consolidation of scattered shares into one holding and the stopping of further fractionization are essential if field boundaries are ever to be brought under modern concepts of run-off control, but in the meanwhile much work is being done on the contour ridging of fields on the existing and often unsatisfactory boundaries.

(*c*) the land revenue authorities are responsible for the records of individual field boundaries and in India and Pakistan the main work of the revenue *patwari* is to record all changes in ownership. His record of field boundaries is an elaborate affair and he holds the whole village economy in his hand ; so he is a power in the land. He does not welcome any proposals which are likely to upset his precious record and so the whole moral force of the revenue subordinates is against any idea of contouring or revision of boundaries. (In Ceylon the revenue records of fields are fragmentary, but there is a general opposition by the owners to any alteration in boundaries.)

(*d*) most governments are averse to using any force or coercion in order to persuade unwilling owners, even when the number of objectors is small. In some cases one may even find that sound legislative measures have been passed and could be applied but local action is withheld because it will be too unpopular. The answer is of course in basic education because an informed public opinion will do more than anything else to coerce the objectors, once the *bona fides* of government and the soundness of the local proposals have been accepted. With primitive populations some form of regimentation is desirable because if the average landowner or tenant is illiterate and ignorant he cannot be expected to know what is really best for his own interest and those of his community. In the case of the contouring of fields the average peasant proprietor knows what water conservation is needed to grow his crops for his peculiar climate, but few indeed have any realization of the harm done by overgrazing and overfelling. The gradualness of deterioration which brings desiccation and gullying as its ultimate end cannot be understood by the countryman whose memory is seldom accurate. Any sort of co-ordination of effort therefore comes easier for ploughland than for waste or grazing land, and so we often find our downstream reclamation for cultivation out-distancing the control of the partially cultivated uplands, which ought of course to come first in priority.

(*e*) common-land is nobody's business. The commons in almost every country are in poorer condition than they ought to be in terms of their natural ecological climax type of vegetation. In India early revenue settlements insisted upon 25 per cent. of the village land being left unploughed in order to guarantee the poor men's grazing rights on the common land, but generally speaking the more grazing provided, the worse are the livestock raised on it, for the less attention is paid to the quality of the stock and breeding control. The districts that have practically no common grazing produce the best plough cattle and milk buffaloes, because every animal is stall-fed and no surplus animals are tolerated. The answer is obviously to organize the remaining common-land so that it becomes some individual's responsibility. This can best be done by forming a co-operative society which can act as if it were a single owner for the common and put it to the best use, either for plough land, rotational grazing, the growing of fuel trees, timber, fruit or fodder-grass, or for water-catching, or all of these combined.

(*f*) the allocation of funds by government to their subordinate departments recalls the Biblical story of the servants' talents, for in times of shortage the revenue-producing activities obviously must be kept going whereas the beneficent activities are the first to be closed down. The best guarantee against this is a periodic plan, for which 5 years is as good a period as any. Once a government has committed itself to supporting such a plan for the development of beneficent activities, it is always a little harder for it to jettison the work. Such a plan also is an essential in the calculation of recruitments and the various grades of technical staff, and the higher the standard of training, as in the officers and rangers' grades, the longer it takes to produce the trained bodies.

(*g*) the voluntary principle for the organization of co-operative societies is an excellent one and should have government's full support in terms of loans on a low interest and an inspection staff to ensure proper organization of each society and the conduct of its business and records. The tendency, however, is for the departmental cadre of inspectors to feel that they can tackle any technical problems themselves rather than call in the appropriate technical department to deal with afforestation, animal husbandry, flood control, public health, or what have you. Another snag is the wide scattering of effort. When a society can be formed on an application of a majority of owners in one village, the tendency is for societies to

spring up as if scattered from a pepper pot. This may suit the co-operative inspectors who like to travel but is the antithesis of what we need in flood control in organizing the whole of one catchment.

(*h*) the natural ability of the cultivator in building his terraced fields is inversely proportional to the average rainfall. Where the rainfall is 8–15 inches, the standard of terracing is exceedingly high because it is only by trapping all of the rain that a wheat crop can be ripened. Where nature is more bountiful the standard is definitely poorer, and it is only in the 20 to 25 inches belt and over that draining off excess moisture becomes a serious problem and elaborate field drainage systems have to be worked out.

The Potash Status of Ceylon Soils

BY

F. M. PONNAMPERUMA

IN recent years, the use of potassic fertilizers has assumed increasing importance in Ceylon. Evidence has begun to accumulate not only of reponse to potassic fertilizers but even of potash deficiency on soils previously assumed to be adequately supplied with potash. Increasing attention is, therefore, now being given to the inclusion of potash in fertilizer mixtures. Unfortunately, the absence of sufficient data on the potash status of Ceylon soils has precluded a rational programme of potassic manuring based on actual soil needs. This investigation was, therefore, undertaken with a view to ascertaining the potash levels of the more important soil types encountered in Ceylon.

An investigation of this kind is beset with many difficulties. Apart from the time and the labour involved in the determination of potassium in soils by chemical methods there is the uncertainty as to the category of potassium that would provide the best index to the potash needs of soils—an uncertainty common to the determination of all of the so-called available nutrients. Clearly, the total potassium content is no criterion of the potash needs of a soil, for soils which contain several thousands of pounds of total potassium in the ploughed layer often respond to as little as 50 lbs. of K_2O per acre. This is because the greater part of the soil potassium is present in the form of complex silicates that weather too slowly to permit the supply of potassium in amounts adequate for the growth of crops. There is evidence, however, that the exchangeable potassium content of a soil is a fairly good criterion of its potash needs (1, 2). As far back as 1934, Magistad (3) had shown that, in Hawaii, pineapple gave no response to potassic fertilizers when the content of exchangeable potassium exceeded 0. 5 m.e. per 100 gms, while Craig (4) in Mauritius found that sugarcane, another heavy feeder of potassium, did not respond to potassic fertilizers when the content of exchangeable potassium exceeded this level. In Ceylon, Salgado (5) has evidence that coconuts show no response when the level of exchangeable potassium is higher than 0 .2. m.e. It is also to be noted that most of the dry zone paddy soils of Ceylon, which have not responded to potash have in the course of this investigation, been found to contain more than 0.2 m.e. of exchangeable potassium.

Though the level of exchangeable potassium of a soil is a useful guide to its potash needs, attempts at quantitative correlation of fertilizer needs with the content of exchangeable potassium have not been wholly successful. Among the factors that render a simple correlation difficult are (i) the fluctuation of the levels of exchangeable potassium as a result of cropping and fertilizer practices, (ii) the extraction by plants of potassium from non-exchangeable forms. Considerable light has been thrown on potash relationships in soils by the researches of American workers during the past two decades and it is now possible to postulate the following equilibria among the different forms of soil potassium (6) :

$$\text{Non-exchangeable K} \rightleftharpoons \text{Exchangeable K} \rightleftharpoons \text{K in soil solution.}$$

The removal of exchangeable potassium by cropping would cause the conversion of some of the non-exchangeable potassium into exchangeable form until the original level of exchangeable potassium is approximately restored. This amount of exchangeable potassium, which remains remarkably constant in many cropped soils from year to year, has been called the characteristic level of exchangeable potassium (7).

In this investigation an attempt has been made to determine the characteristic levels of exchangeable potassium. To this end, samples were taken, as far as possible, from unfertilized fields which had been fallow for some time. Total potassium and total exchangeable bases, too, were determined to see what relationship exchangeable potassium bore to them.

METHODS

All determinations were carried out with composite samples from each locality, taken to a depth of 6″. The samples were air dried, passed through a 2 mm. sieve and the fine earth used for analysis.

Exchangeable potassium and total exchangeable bases were determined with ammonium acetate extracts obtained by leaching the soils with normal ammonium acetate at pH 7 (8). Ammonium acetate was used in preference to other leaching agents because it permitted the simultaneous determination of total exchangeable bases. Besides, on account of the blocking effect of the ammonium ion on the release of non-exchangeable potassium, this method gives a clear-cut separation of exchangeable potassium (9).

Suitable aliquots of the ammonium acetate extracts were evaporated to dryness to expel the excess of ammonium acetate and the residues gently ignited to convert the acetates into carbonates, as suggested by Salgado (10). The potassium was determined volumetrically by the modified cobaltinitrite method proposed by Wilcox (11). Total exchangeable bases were determined

by the method of Bray and Willhite (12). Total potassium was extracted by Hall's method, as described by Piper (13). According to Piper (14), forty-eight hours digestion with constant boiling hydrochloric acid extracts all but a small proportion of the total potassium. The extracts were evaporated to dryness, gently ignited and the potassium in the aqueous extracts of the residues determined as before.

RESULTS

The Sands and Sandy Loams Derived from the Pleistocene Plateau Deposits of the Western and North-Western Provinces

TABLE 1

Locality	*Soil Type*	*Total K* (*Per cent.*)	*Total Ex. bases* (*m.e./100 gm*)	*Ex. K* (*m.e./100 gm*)	*Ex. K* / *Ex. bases* as %	*Ex. K* / *Total K* as %
Ngombo ..	white sand ..	0.008 ..	0.098 ..	0.017 ..	17.3 ..	8.5
Wennapuwa ..	Brown sandy loam ..	0.035 ..	1.30 ..	0.124 ..	9.5 ..	13.9
Marawila ..	Reddish brown sandy loam	0.099 ..	1.72 ..	0.234 ..	13.6 ..	9.3
Bingiriya ..	Greyish brown sandy loam	0.040 ..	0.63 ..	0.123 ..	19.3 ..	11.4
Puttalam ..	Red sandy loam ..	0.106 ..	1.36 ..	0.219 ..	16.1 ..	8.1

The content of total potassium and of exchangeable potassium is related to the texture of the soils and rainfall. The highly leached sands of the Negombo area, as typified by the white cinnamon soil, are extremely low, the brown sandy loams of Wennapuwa and Bingiriya low, and the reddish soils of Marawila and Puttalam are moderately high in both total and exchangeable potassium. In spite of the low rainfall the Bingiriya soil is low in both constituents on account of its very coarse texture. The proportion of exchangeable potassium to exchangeable bases is higher than for average soils.

A low content of exchangeable potassium does not necessarily point to the need for potassic fertilizers, for, there is always the possibility of the release of potassium from non-exchangeable forms to meet the demands of a crop. However, in the case of the strongly weathered soils of Negombo and Wennapuwa, it is unlikely that clays of the illitic type, that are responsible for the release of potassium, are present. Therefore, on the basis of Salgado's finding that .2 m.e. represents an adequate level of exchangeable potassium, it may tentatively be stated, that for coconuts, the main crop of the area, the white sandy soils of Negombo would require approximately 200 lbs. of K_2O per acre, the brown sandy loams of Wennapuwa about 75 lbs. of K_2O, and the reddish soils of Marawila and Puttalam probably no potassic fertilizers for high yields. No conclusions can be drawn for the soils of Bingiriya, a drier region, in view of the uncertainty of the nature of its clay fraction.

The Highland Soils of the Dry Zone

TABLE 2

Locality	*Soil Type*	*Total Potassium Per cent.*	*Total Ex. bases m.e./100 gm*	*Ex. K m.e./100 gm*	*Ex. K / Ex. bases as %*	*Ex. K / Total K as %*
Pelwehera ..	Reddish brown loam	.. 0.202	.. 8.6	.. 0.474	.. 5.5	.. 9.9
Maha Illu-palama	do.	.. 0.133	.. 9.2	.. 0.663	.. 7.2	.. 19.5
Vavuniya ..	do.	.. 0.075	.. 10.7	.. 0.450	.. 4.2	.. 23.4
Hingurakgoda	do.	.. 0.123	.. 13.9	.. 0.394	.. 2.8	.. 12.2
Mankulam ..	do.	.. 0.144	.. 9.0	.. 0.776	.. 8.5	.. 21.0
Nikeweratiya..	Grey loam	.. 0.077	.. 9.0	.. 0.421	.. 4.7	.. 22.9
Tabbowa ..	do.	.. 0.164	.. 11.5	.. 0.550	.. 4.8	.. 13.1
Wariyapola	Grey sandy loam	.. 0.035	.. 3.3	.. 0.149	.. 4.5	.. 16.7
Wirawila ..	do.	.. 0.338	.. 5.1	.. 0.510	.. 10.0	.. 5.9
Mulliavelli ..	Red loam	.. 0.081	.. 3.7	.. 0.242	.. 6.5	.. 11.7
Trincomalee ..	Reddish brown loam	.. 0.157	.. 4.0	.. 0.335	.. 8.4	.. 8.3

The reddish brown lateritic and the grey non-lateritic loams of the dry zone are relatively high in total potash and in exchangeable bases but especially high in exchangeable potassium. The average content of exchangeable potassium is .55 m.e. per 100 gm. These soils are not likely to show any response to potassic fertilizers even under the most exacting crops.

The grey sandy loams, especially the light textured soils of Wariyapola, are relatively low in both total and exchangeable potassium though these levels are higher than in the case of the more heavily leached soils of comparable texture in the Western Province. The potash needs of these soils cannot be predicted in view of the possibility of release of potassium from clay minerals.

The ratio of potassium to total bases is much lower and nearly more constant for the typical dry zone soils than for the soils described earlier. The ratio of exchangeable to total potassium shows more variability and is high.

The Paddy Soils of the Dry Zone

TABLE 3

Locality	*Soil Type*	*Total K (Per cent.)*	*Total Ex. bases m.e./100 gm*	*Ex. K m.e./100gm*	*Ex. K / Ex. bases (%)*	*Ex. K / Total K (%)*
Anuradhapura	Grey loam	.. 0.127	.. 7.69	.. 0.226	.. 2.9	.. 7.0
Vavuniya ..	do.	.. 0.067	.. 6.56	.. 0.223	.. 3.4	.. 12.9
Paranthan ..	Grey sandy loam	.. —	.. 2.62	.. 0.080	.. 2.3	.. —
Lady Ramana-than Farm	Grey loam	.. 0.077	.. 4.79	.. 0.164	.. 3.5	.. 8.4
Wariyapola ..	Light grey sandy loam	0.016	.. 4.08	.. 0.080	.. 2	.. 19.3
Nikeweratiya..	Grey loam	.. 0.067	.. 6.82	.. 0.171	.. 2.5	.. 10
Tabbowa ..	Dark grey heavy clay	.. 0.303	.. 29.6	.. 0.688	.. 2.3	.. 8.7

As in the case of the highland soils, the content of total and exchangeable potassium as well as total exchangeable bases varies with the content of colloidal matter. With the exception of the two loams from Anuradhapura and Vavuniya and, of course, the heavy clay from Tabbowa the soils are all low in both total and exchangeable potassium. The uncertainty of the nature of the clay fraction of these soils precludes a prediction of their potash needs but the low content of exchangeable potassium taken in conjunction with the low levels of total potassium point to the desirability of potassic fertilizers on these soils, for maximum yields.

A remarkable feature is the low variability of the ratio of exchangeable potassium to total exchangeable bases and its approximation to half the average value of the ratio for the highland soils of the same climatic zone. The reduction in the ratio may be attributed to the preponderance of divalent cations in percolating and irrigation waters and their absorption and retention by the paddy soils.

The Highland Soils of the Wet Zone

TABLE 4

Locality	*Soil Type*	*Total Potassium (K) Per cent.*	*Total Ex. bases m.e./100 gm*	*Ex. K m.e./100 gm*	*Ex. K / Ex. bases as %*	*Ex. K / Total K as %*
Ulapane ..	Lateritic loam	.. 0.110	.. 2.18	.. 0.189	.. 8.7	.. 6.7
Mawanella ..	Lateritic clay	.. 0.137	.. 4.24	.. 0.292	.. 6.6	.. 8.3
Gampola ..	do.	.. 0.105	.. 1.20	.. 0.086	.. 7.2	.. 3.2
Ambampitiya	Gravelly laterite clay	.. 0.106	.. 1.18	.. 0.102	.. 8.7	.. 3.7
Warakapola ..	Gravelly laterite loam	.. 0.142	.. 1.16	.. 0.123	.. 10.6	.. 3.4
Mahara ..	do.	.. 0.069	.. 1.22	.. 0.062	.. 5.1	.. 3.5
Veyangoda ..	do.	.. 0.140	.. 1.43	.. 0.141	.. 9.9	.. 3.9

The laterite and lateritic soils of the highlands of the wet zone are generally low in both total and exchangeable potassium. In view of the small number of soils examined it is not safe to generalize but the indications are that the laterite soils are poorer than the lateritic soils in both exchangeable bases and exchangeable potassium. Further, in view of the high percentage of gravel in the laterite soils their content of exchangeable potassium on an acre basis is bound to be considerably lower than the figures would indicate. The ratio of exchangeable potassium to total exchangeable bases for both groups of soils is slightly higher, while the proportion of exchangeable to total potassium is lower, than the corresponding ratios for the dry zone soils.

On the assumption that .2 m.e. of exchangeable potassium represents an adequate level these soils would require up to 100 lbs. K_2O as fertilizer for high yields.

The Paddy Soils of the Wet Zone

TABLE 5

Locality	*Soil Type*	*Total Potassium (Per cent.)*	*Total Ex. bases m.e./100 gm*	*Ex. K m.e./100 gm*	*Ex. K / Ex. bases as %*	*Ex. K / Total K as %*
Ambampitiya	Dark brown lateritic clay	0.162	1.63	0.246	15.1	5.9
Gampola	Dark brown heavy lateritic clay	0.163	2.35	0.232	9.4	5.5
Gampaha	Dark brown laterite clay	0.083	1.98	0.164	8.2	8.2
Warakapola	Dark brown laterite clay	0.142	1.14	0.118	10.4	3.2
Veyangoda	Dark brown heavy laterite loam	0.156	1.70	0.173	10.2	4.3
Horana	Dark grey laterite clay	0.123	2.55	0.164	6.4	5.3

The heavy lateritic paddy soils of the mid-country appear to be adequately supplied with exchangeable potassium, the levels being comparable to those of the coarser textured soils of the dry zone. Inasmuch as the exchangeable potassium content of these soils exceeds .2 m.e. it is unlikely that these soils will require assistance from potassic fertilizers. This would however, have to be confirmed by field experiments.

The laterite clays of the ultra wet zone, in spite of their heavy texture, do not have levels of exchangeable potassium that can be considered adequate. If .2 m.e. is considered a satisfactory level these soils may tentatively be said to require about 50 lbs. K_2O per acre for optimum yields.

The ratios of exchangeable potassium to total exchangeable bases and of exchangeable to total potassium are comparable to those of the highland soils of the wet zone.

The Wet Patana Soils

TABLE 6

Locality	*Soil Type*	*Total K Per cent.*	*Total Ex. bases m.e./100 gm*	*Ex. K m.e./100 gm*	*Ex. K / Ex. bases*	*Ex. K / Total K*
Ambawela	Black heavy loam	0.261	1.20	0.247	20.5	3.7
Hakgala	do.	0.188	1.48	0.258	17.4	5.4
Bopatalawa	Black clay soil	0.261	1.90	0.392	20.6	5.9

The wet patana soils are comparatively high in both total and exchangeable potassium. A striking feature of these highly leached soils is the high proportion of potassium in the exchangeable bases. The ratio of exchangeable to total potassium is of the same order as the ratio for the other soils of the wet zone.

These soils carry adequate supplies of reserve and exchangeable potassium and are unlikely to respond to potassic fertilizers.

The Soils Derived from Limestone

TABLE 7

Locality	*Soil Type*	*Total K (Per cent.)*	*Total Ex. bases m.e./100 gm*	*Ex. K m.e./100 gm*	*Ex. K / Ex. bases as %*	*Ex. K / Total K as %*
Jaffna ..	Red calcareous loam ..	0.294 ..	— ..	0.599 ..	— ..	7.9
Kankesanturai	do. ..	0.315 ..	— ..	0.643 ..	— ..	7.9
Nalanda ..	Chocolate brown loam ..	0.119 ..	6.51 ..	0.471 ..	7.4 ..	15.3

The red calcareous loams of the Jaffna peninsula, derived from Miocene limestone, have abundant supplies of both reserve and exchangeable potassium. They are not likely to show any response to potassic fertilizers. The chocolate brown loam, derived from dolomitic limestone, though low in reserves of potassium, is well supplied with exchangeable potassium. On these soils, too, potassic fertilizers would be superfluous.

The Dry patana soils.

The two dry patana soils examined (one from Erebedde and the other from Welimada) were low in exchangeable potassium, the level being about 0. 1 m.e. They are likely to benefit by the application of potash up to about 100 lb. K_2O per acre.

SUMMARY AND CONCLUSIONS

The characteristic levels of exchangeable potassium of the more important soil types encountered in Ceylon are reported. The relation they bear to the levels of total exchangeable bases and to total potassium is also indicated.

The coarse textured soils, irrespective of the climatic zone in which they occur, are low in exchangeable potassium. The need for relatively large applications of potash are, however, indicated only for the highly leached soils. The potash needs of the coarse textured soils of the dry zone cannot be predicted in view of the possibility of release of potassium from the clay fractions of these soils, but where levels of both total and exchangeable potassium are low, the use of potassic fertilizers is advisable. The medium and heavy textured soils of the dry zone are well supplied with exchangeable potassium. So are the red soils of Jaffna and the chocolate brown soils of Nalanda. Potassic fertilizers would be superfluous on these soils. The wet patana soils, too, are well supplied with exchangeable potassium and are unlikely to show any response to potassium. The lateritic soils of the mid-country, particularly the paddy soils, carry adequate amounts of exchangeable potassium. It is unlikely that potash is a limiting factor on these soils. Apart from the sandy soils of the Western Province, the soils for which the need for potassium is indicated are the paddy and highland soils of the ultra-wet zone and the dry patana soils. These soils, in spite of their relatively high clay content, do not carry adequate supplies of exchangeable potassium. Since it is unlikely that clays of the illitic type that release potassium are present in these highly leached soils, the deficiency of exchangeable potassium has to be made good by the application of potassic fertilizers. Application of potash up to 100 lb. K_2O per acre are indicated for these soils.

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Residual Effects from Superphosphate, Basic Slag and Bonemeal on Some Paddy Soils in Lower Burma

BY

D. RHIND AND U. TIN

THE large number of fertilizer trials carried out in the past on paddy in Burma have demonstrated the frequent large and paying residual effects which follow dressings of farmyard manure and phosphates. The present paper examines some phosphate residuals, which are well known, but concerning which there seem to be few data for tropical paddy soils. Where such data exist they often cover too short a period to reveal the whole of the long-sustained effects of common phosphatic fertilizers. This appears to be chiefly due to the experiments as a whole soon failing to attain significance when the usual analysis of variance is applied to plot yields year by year. Such experiments are often continued for only two, three or four years and then abandoned because the residual effects have fallen to a level where the experiment as a whole does not attain significance. Residual effects do not come to a sudden stop and they require different statistical treatment from the primary effects resulting from the initial dose of the fertilizer. Under rotational cropping systems assessment of the residuals is seriously complicated, but when, as in Burma rice fields, monoculture is the rule, it is possible to compare yield differences between successive crops. Each succeeding crop on land giving a residual response to a fertilizer shows a decreasing increment over the untreated, apart from anomalous results which may arise from the poorly controlled nature of such measurements, seasonal effects, &c. The efficiency of variance analysis applied to residual effects is considerably lower than when applied to the initial response because of seasonal changes and other uncontrollable variables which are unavoidably introduced with each additional time interval. The " die-away " nature of residuals requires that they be treated by fitting appropriate curves. The potential residual effect of a fertilizer will vary according to the kind and quantity of fertilizer applied to each soil, the kind of crop and the climatic conditions. We have attempted to estimate this residual potential for three forms of phosphate on two Lower Burma soils with paddy as a single monsoon crop grown without rotation.

There were two experiments, at Hmawbi and Myaungmya farms, both in the delta of the Irrawaddy. The soils are acid, recent alluviums, lateritic and under a monsoon rainfall of about 100 inches a year falling mostly between May and October. Analyses of the soils are given in Appendix I but these apply to the farm soils as a whole and not specifically to the experimental plots, though there is no reason to suppose there was any important

difference. The fertilizers were applied once, shortly before the first crop was transplanted, at the rate of 50 lb. P_2O_5 per acre. The analysis of the fertilizers is given in Appendix II. The same variety of paddy, the pure line C 14—8, was used at both stations throughout the experiments.

Part of the active constituent of the fertilizer disappears each year from the soil either as that part absorbed by the crop and removed with it or that part lost by leaching, erosion or by becoming permanently unavailable and thus losing its potentiality. However it may be removed or lost, $1 - p$ and p may be taken as representing the fraction of the fertilizer used and or lost and the fraction left in the soil to be available to future crops either at once or by slow changes. It is assumed (*a*) that the seasonal changes affect the yields of the manured and unmanured plots alike, (*b*) that the increments in yield over the unmanured depend entirely or almost entirely on the intake of the fertilizer by the crop and (*c*) that the potentiality of the fertilizer depends entirely on the proportion left available or to become available. Then if ..... p^1, p^2, p^3 ..... p^n are the fractions of the fertilizer left over in the 1st, 2nd, 3rd ..... nth years, $\frac{p^1}{p^2} + \frac{p^2}{p^3} + \ldots\ldots \frac{p^{n-1}}{p^n} = \frac{I_1}{I_2} + \frac{I_2}{I_3} + \ldots\ldots + \frac{In_1}{I_n}$ = Sum of the increment ratios for n years, where I is the increment over controls in each year of the residual effect. The value of p, the residual coefficient, is then determined. From the calculated residual coefficients a regression is fitted, $Y_I = \bar{y}_I + b\,(x - \bar{x})$ where Y_I is the yield increment and x the residual potentials p^1, p^2 ..... p^n. Using this method the curves are drawn (Figs 1 to 4).

TABLE I

Observed and Calculated Increases over Controls in lb. of Paddy per Plot. Myaungmya and Hmawbi Farms

(plots 1/60 acre)

A. Myaungmya

Residual Year	*Basic slag*		*Bonemeal*		*Superphosphate*	
	Obs.	*Calc.*	*Obs.*	*Calc.*	*Obs.*	*Calc.*
1st ..	15.3 ..	16.1 ..	22.0 ..	22.3 ..	16.2 ..	18.0
2nd ..	18.2 ..	14.5 ..	19.7 ..	20.5 ..	15.4 ..	15.0
3rd ..	8.7 ..	13.0 ..	22.0 ..	18.8 ..	17.7 ..	12.7
4th ..	12.3 ..	11.8 ..	14.8 ..	17.3 ..	8.1 ..	10.8
5th ..	11.7 ..	10.8 ..	16.4 ..	15.9 ..	8.5 ..	9.4
Mean ..	13.44 ± 4.17		18.98 ± 3.24		13.18 ± 4.83	

B. Hmawbi

Residual Year	*Basic slag*		*Bonemeal*		*Superphosphate*	
	Obs.	*Calc.*	*Obs.*	*Calc.*	*Obs.*	*Calc.*
1st ..	15.0 ..	18.9 ..	10.9 ..	15.0 ..	17.0 ..	18.3
2nd ..	18.5 ..	14.3 ..	16.0 ..	12.0 ..	14.5 ..	14.0
3rd ..	17.5 ..	11.3 ..	18.0 ..	11.4 ..	15.6 ..	11.0
4th ..	7.0 ..	9.3 ..	8.0 ..	10.1 ..	6.0 ..	8.8
5th ..	4.0 ..	8.1 ..	5.7 ..	9.2 ..	6.3 ..	7.3
Mean ..	10.40 ± 6.96		11.72 ± 6.61		11.88 ± 4.22	

The observed and calculated yields show that the residual potentiality of the fertilizers depends on the proportion left available, or to become available, in the soil.

Applying the method described it is possible to extend the curves of residual responses to points beyond that of the last residual year, the fifth. This is justified by the fact that, as shown by the observed differences given in Table I, considerable residual effects still remained at the end of the fifth year. The curves in Figs. 1 and 2 show the character of the residual responses from these three fertilizers. It would have been more satisfactory if more data covering a longer period had been available, but that is rarely the case with residual trials in the past.

To express the residual responses by a term which would enable easy comparison to be made between one fertilizer or soil and another and which would embrace in such term the characteristics of the residual response in time, use has been made of the half-life period, by analogy with the method of expressing radioactive decay. A second method of expressing the rate of decline in residual responses is by the time required for the response to fall to an arbitrary level which is considered to be the minimum response which a farmer would recognize or which might be considered as economically important. In the present case, the lowest response considered of practical value has been set at 150 lb. paddy per acre. Table II shows the results in the present experiments of expressing the residuals by these two methods.

TABLE II

Residual effects in terms of number of crops taken in the half-life period and in the time before the increment over the unmanured falls below 150 lb. of Paddy per Acre

Fertilizer	*Myaungmya*		*Hmawbi*	
	No. of Crops in half-life period	*No. of responses above 150 lb. paddy per acre*	*No. of Crops in half-life period*	*No. of responses above 150 lb. paddy per acre*
Bonemeal ..	9 ..	10 ..	8 ..	7
Superphosphate ..	5 ..	4 ..	3 ..	4
Basic Slag ..	8 ..	5 ..	4 ..	5

While the half-life expresses the real persistency of the residual effect the number of crops which can be taken with increases of over 150 lb. of paddy per acre above the unmanured is of greater practical importance. The two expressions are quite distinct, as shown by the cases of basic slag and bonemeal at Myaungmya, where while basic is nearly as persistent as bonemeal and has a half-life only one crop less it is not nearly so profitable because the increment from it falls below 150 lb. after only the fifth crop. Its behaviour at Hmawbi is different. At this farm it has a lower persistency as shown by its short half-life of only four crops, but it is more effective, since it gives five crops with increments of over 150 lb. above the control. The great superiority of bonemeal, both in persistency and degree of response, over the other fertilizers is clear and this superiority is the greater when it is remembered that at the time of these experiments the costs of the fertilizers on a P_2O_5 basis were in the ratio bonemeal : super : basic = $6\frac{1}{2}$: 10 : 18.

Table III shows calculated increases in pounds of paddy per acre for these three fertilizers for the initial and residual years down to increments of 150 lb. per acre above the unmanured.

TABLE III

Calculated Increases of Paddy in lb. per Acre over Unmanured from Dressings of 50 lb. P_2O_5 per acre with three Fertilizers. Increases below 150 lb. per acre omitted

	Myaungmya			*Hmawbi*		
	Basic	*Super*	*Bonemeal*	*Basic*	*Super*	*Bonemeal*
Initial gain (observed)	338	360	458	416	303	501
Calculated residuals—						
1st	242	270	335	358	346	284
2nd	217	226	307	271	265	245
3rd	196	191	282	214	208	215
4th	177	163	260	177	167	192
5th	162	—	239	153	—	175
6th	—	—	220	—	—	161
7th	—	—	203	—	—	151
8th	—	—	188	—	—	—
9th	—	—	174	—	—	—
10th	—	—	161	—	—	—
Total of residuals (150 lb. increases and above)	994	850	2,369	1,173	986	1,423
Total gain lb. of paddy per acre initial plus residuals	1,332	1,210	2,827	1,589	1,289	1,924

In the case of super at Hmawbi, the initial response is below that calculated for the first residual. This is because the residuals are estimates from the formula while the initial responses are observed figures.

That phosphates give good results with payable residuals on the paddy soils of Burma has been known for a long time, but their persistency seems to be greater than had been realised. There may be other data for tropical soils more complete than those we have had to use which would repay re-examination.

It may be noted that in laying down manurial trials the probable long effects of previous phosphatic dressings makes it essential to avoid such fields for long periods, up to 17 years in the case of bonemeal dressings at Hmawbi.

SUMMARY

1. An examination has been made of the residual effects of three phosphatic fertilizers on two Lower Burma paddy soils by a method of fitting curves.

2. The responses are found to persist for a number of years which, when only increases of 150 lb. or more of paddy per acre are considered, may last from four to ten years.

3. By expressing the effect as the half-life period of the fertilizer, comparisons can be made of the variation in persistency between responses from different fertilizers on different soils.

4. On the acidic alluviums of Lower Burma the superiority of bonemeal over super and basic slag was considerable, both in persistency and cost.

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1. Hmawbi Experimental Farm Annual Reports.
2. Myaungmya Experimental Farm Annual Reports.

APPENDIX I

Soil Analyses of Hmawbi and Myaungmya Farms

	Myaungmya	*Hmawbi*
Insoluble residue	72.19	63.87
Soluble silica	—	15.26
Ferric oxide (Fe_2O_3)	4.19	3.63
Alumina (Al_2O_3)	9.74	10.07
Lime (CaO)	0.12	0.29
Magnesia (MgO)	0.46	2.29
Potash (K_2O)	0.27	0.57
Soda (Na_2O)	0.17	0.36
Sulphuric acid (SO_3)	0.12	0.08
Phosphoric acid (P_2O_5)	0.03	0.03
Carbon dioxide (CO_2)	0.11	0.02
Organic matter and combined water	8.07	5.53
Manganese oxide (Mn_3O_4)	0.06	—
Organic carbon	2.234	—
Organic nitrogen	0.171	0.72
Available P_2O_5	0.0024	0.0029
Available K_2O	0.0092	0.0147
pH	5.5	6.1

	Myaungmya	*Hmawbi*
Gravel, stone and fine gravel	—	—
Coarse sand	7.3	3.9
Fine sand	10.0	2.9
Silt	24.0	33.1
Fine silt	40.6	43.5
Clay	14.8	9.1

APPENDIX II

Analyses of Fertilizers used at both Hmawbi and Myaungmya

	Bonemeal	*Super*	*Basic slag*
Moisture	9.79	10.47	0.50
Total P_2O_5	19.45	19.94	14.63
Water soluble P_2O_5	—	18.93	traces
Citrate soluble P_2O_5	—	1.01	12.60
Citrate insoluble P_2O_5	—	—	2.03
Nitrogen	3.52	—	—
$Ca_3 (PO_4)_2$	42.40	—	31.91
Fineness—			
100 mm	6.7%		69.5%
50 mm	21.0%		
10 mm	72.3%		

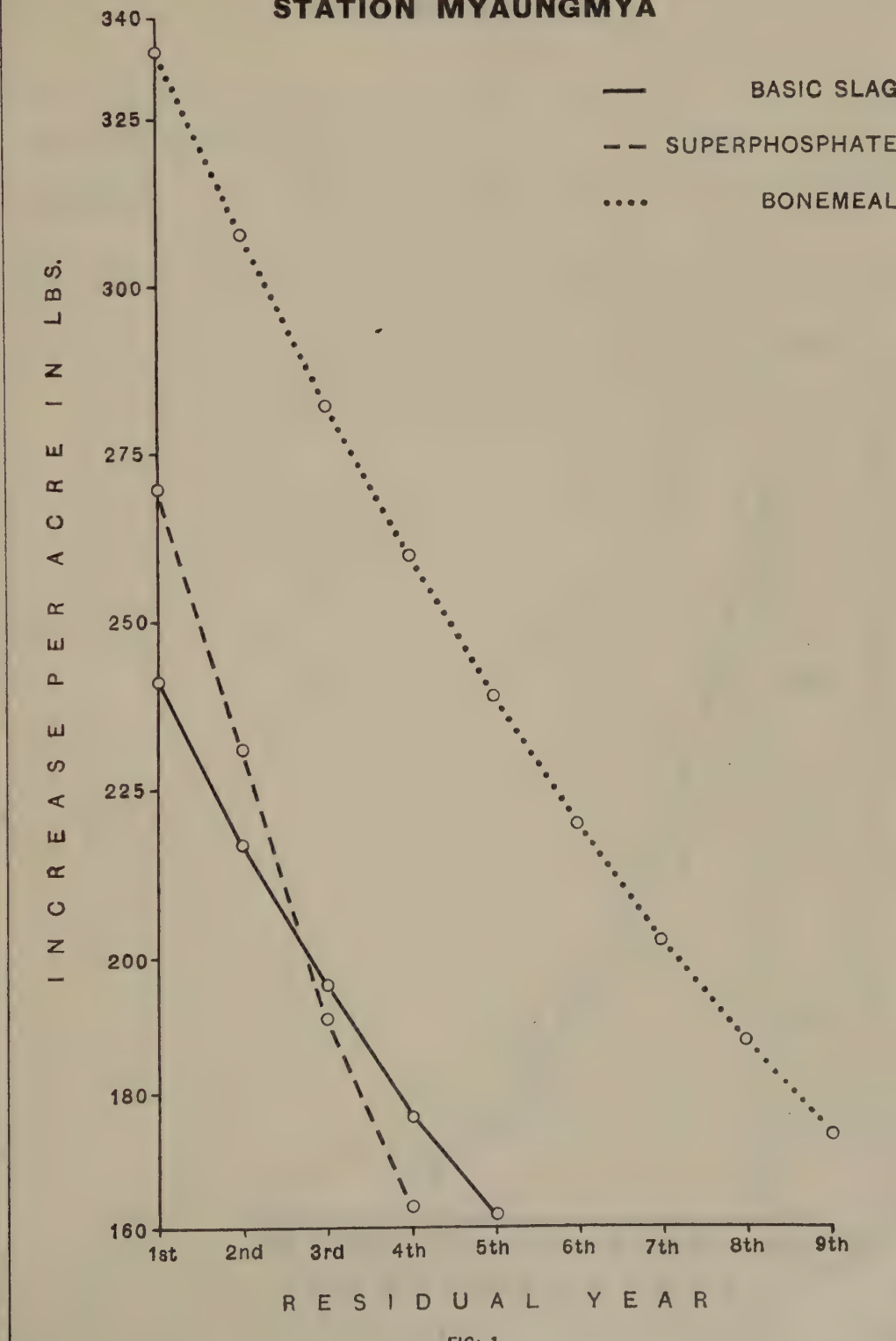

FIG: 1

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STATION HMAWBI

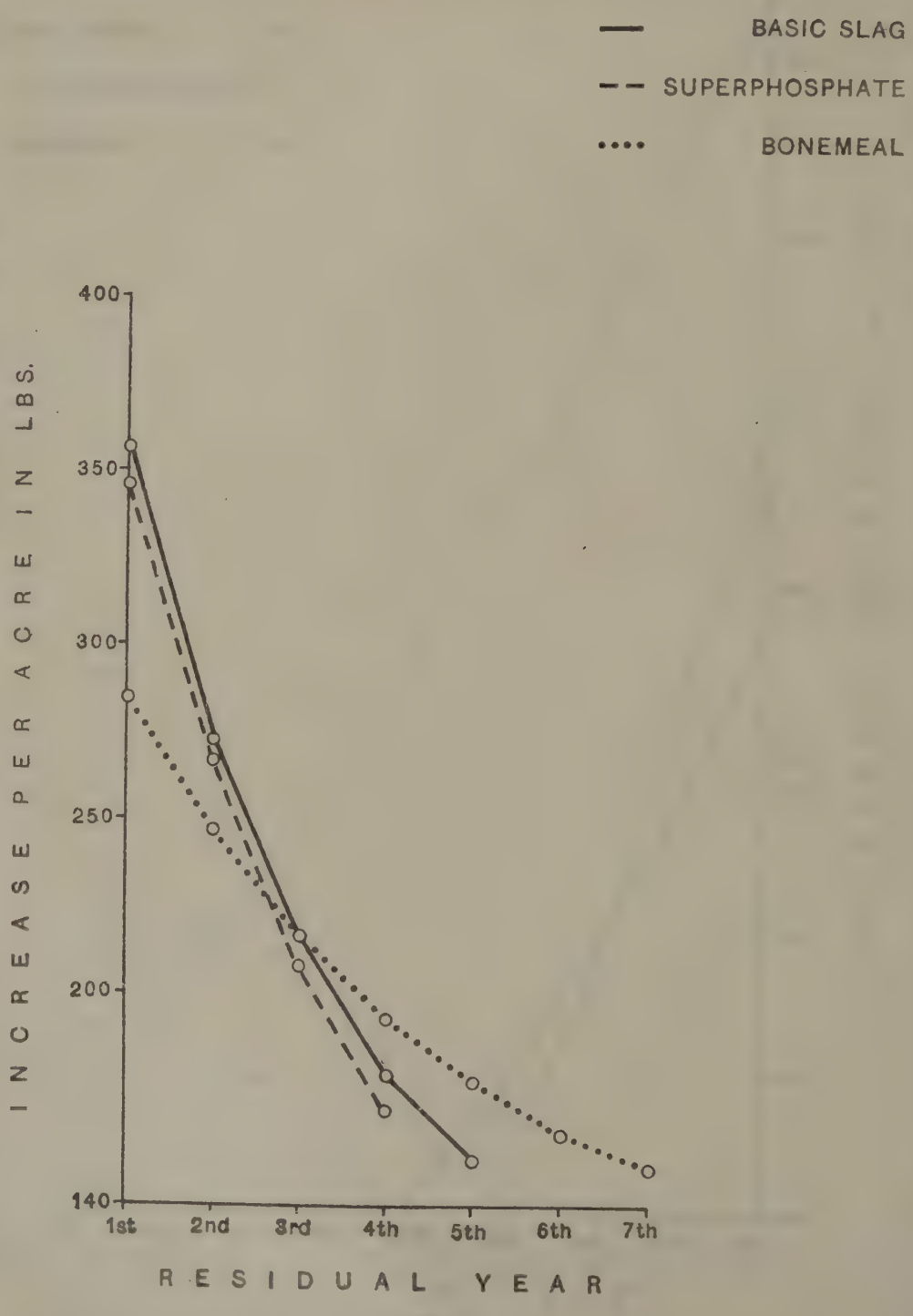

FIG: 2

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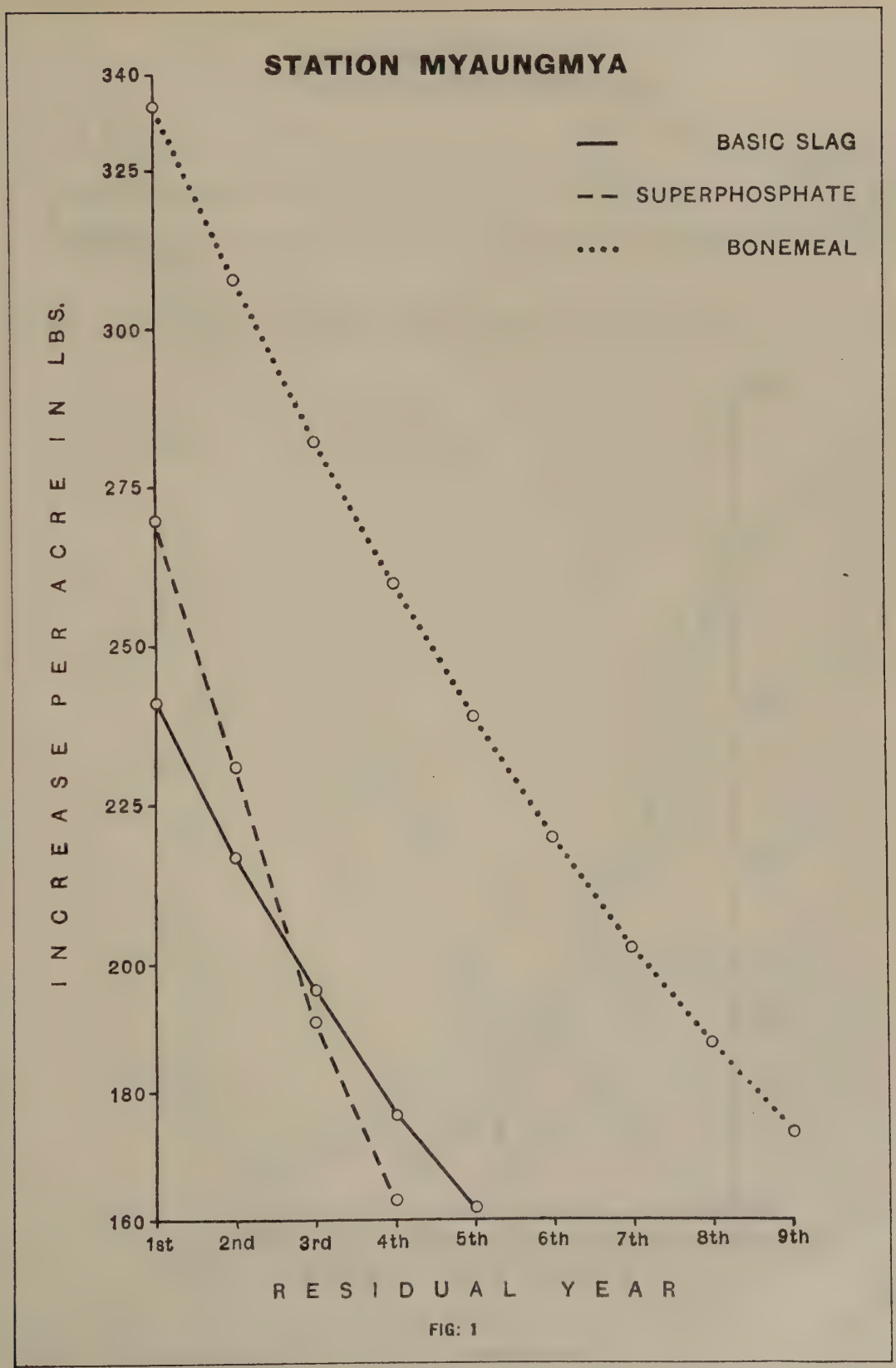

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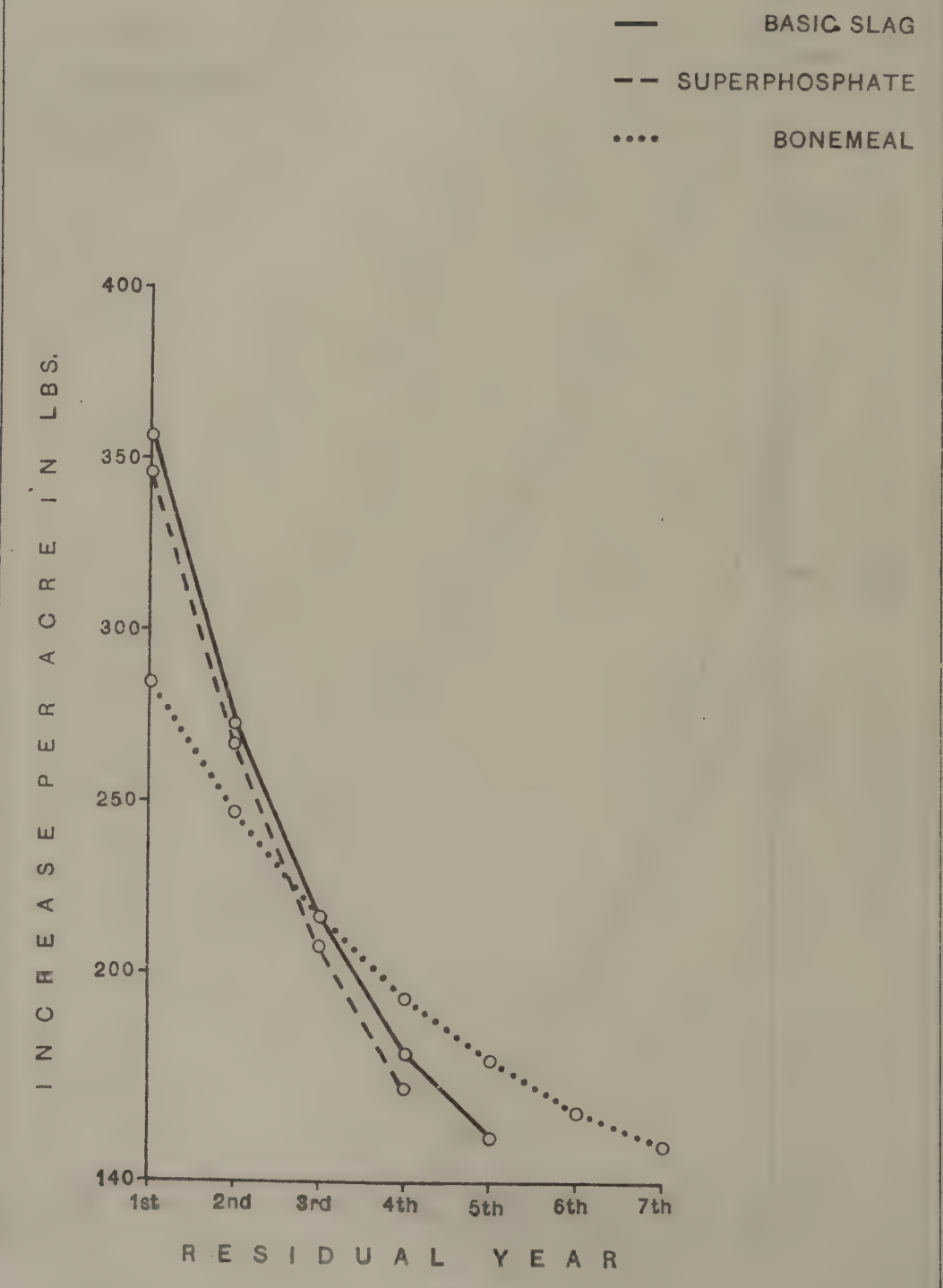
STATION HMAWBI



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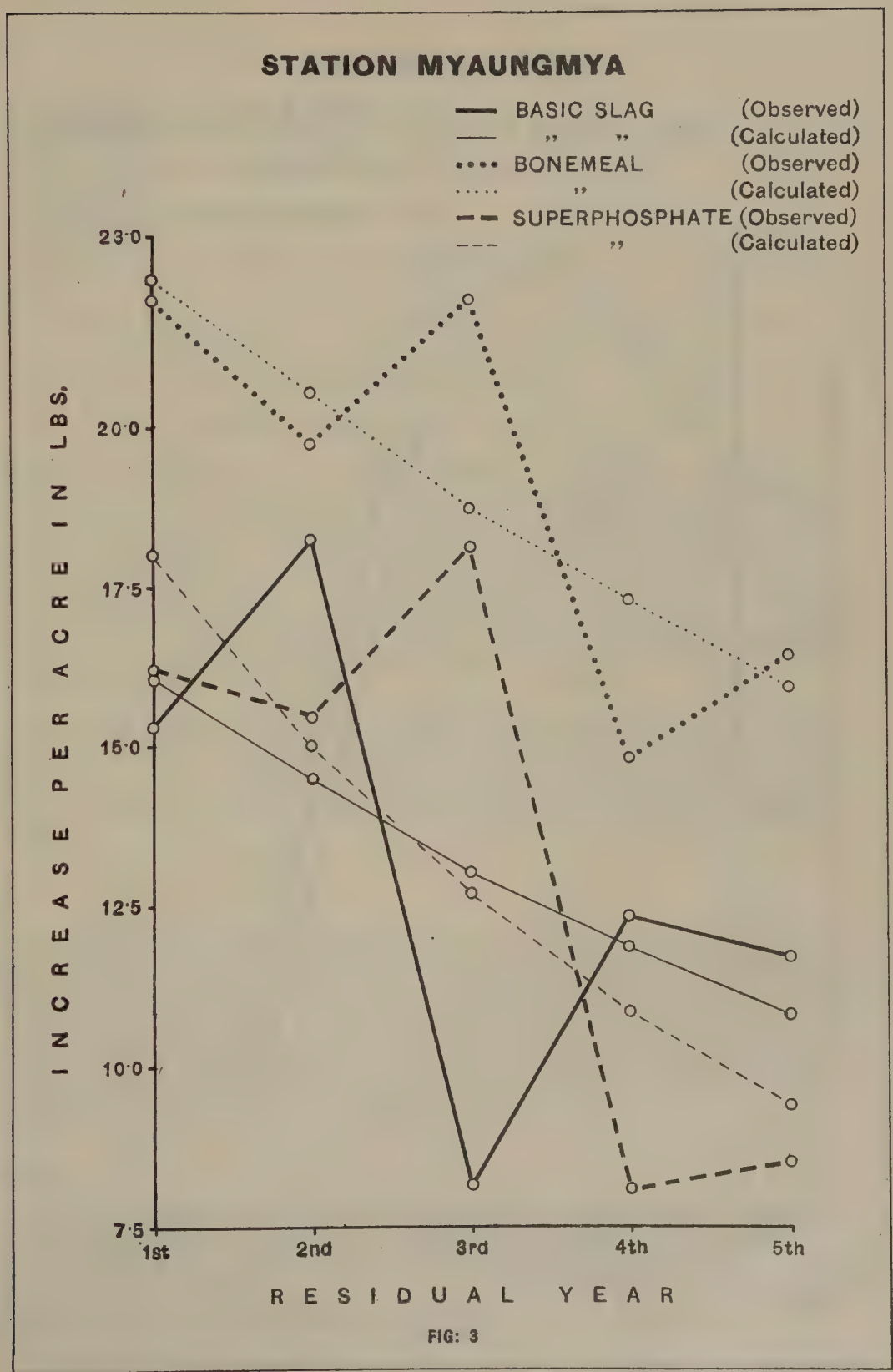

FIG: 3

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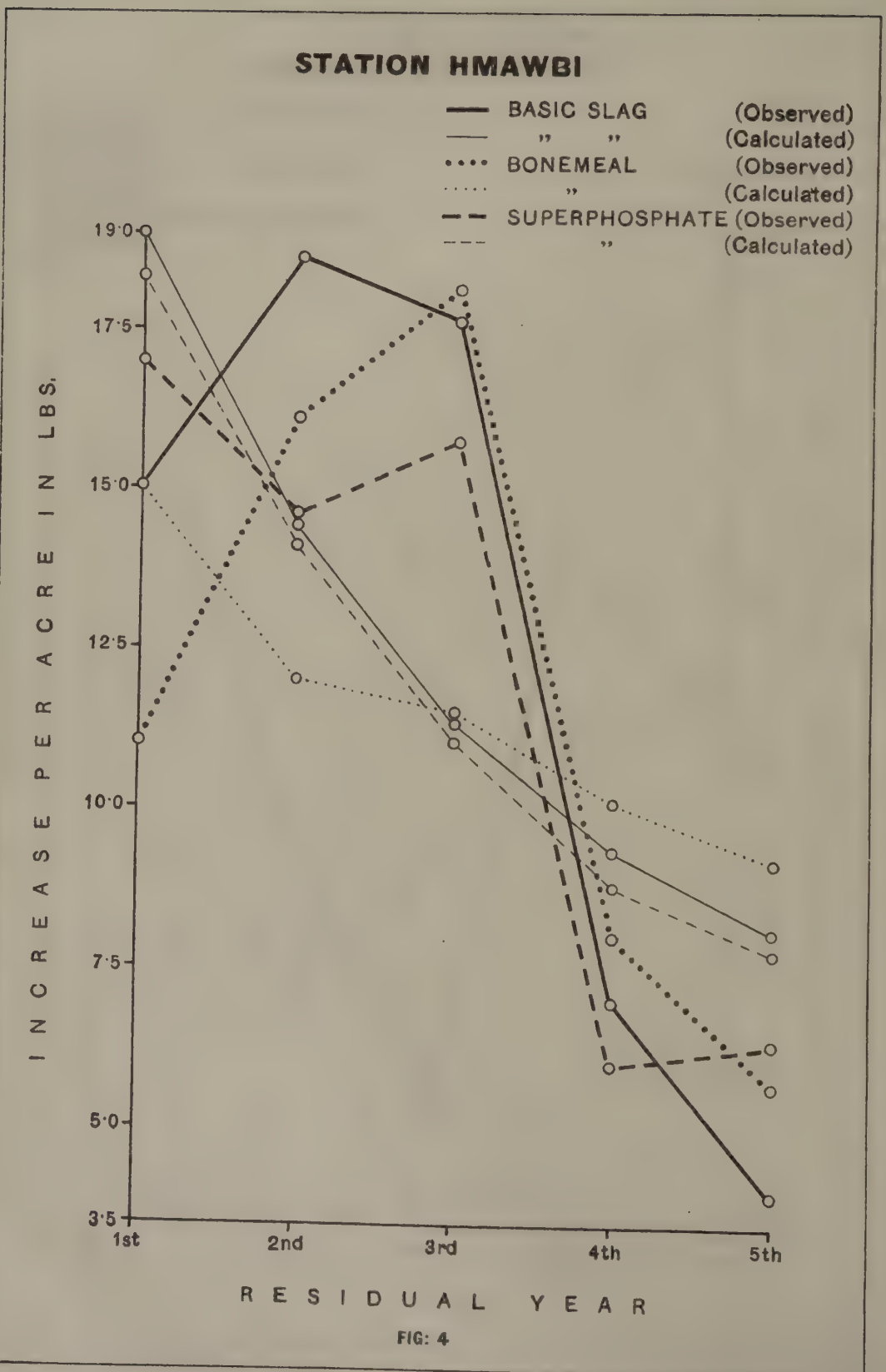

FIG: 4

PRINTED BY SURVEY DEPT., CEYLON 1952.

Drug Plants (Indigenous and Exotic) that can be grown in Ceylon–Part II

BY

D. M. A. JAYAWEERA

(Part I of this Series was published in the Tropical Agriculturist, Vol. CI, July–September 1945, and it is proposed to continue the series in this and subsequent publications.)

BALSAMUM PERUVIANUM—Balsam of Peru

THIS is obtained from the trunk of *Myroxylon Pereirae* (Royle) Klotzsch, a tree about 50 feet in height with ascending and spreading branches growing in the forests of Central America, belonging to the family *Leguminosae*. It has a thick smooth grey straight trunk and pinnate leaves. The leaflets are alternate, two to five pairs, ovate—lanceolate, acute at the apex somewhat emarginate and shining above. Flowers are small, white occurring in axillary racemes. The fruit is a pendulous samara about two inches long compressed, membranous winged and one seeded. This tree can be cultivated in Ceylon.

Balsam is not a normal secretion of the tree but has to be induced by beating the bark which is then removed and the trunk scorched. As the Balsam comes out it is soaked in rags with which the wounded parts are covered. The rags are then pressed and the crude Balsam thus obtained is purified by boiling with water.

History

Monardes of Seville describes the drug under the heading "Del Balsamo" in 1565. Probably it was introduced into Europe about 1524. As a result of representations made by the missionary priests of Central America, Pope Pius V in a document issued on August 2, 1571, granted permission to the Bishops of the Indies to substitute the Balsam of Guatemala for that of Egypt in the preparation of the Chrism used in the Roman Catholic Church. The tree was introduced into Mexico in the 16th century.

Composition

Balsam consists of an oily fluid mixed with a dark resin. The fluid constitutes about 53–66% of the commercial drug and consists of benzyl benzoate and benzyl cinnamate. The resinous portion containing about 28% of the drug consists of the esters of cinnamic and benzoic acids. In addition the drug contains peruviol, an alcohol with a sweet odour and taste.

2—J. N. B 18602 (7/52)

Uses

It is used externally as an antiseptic and a parasiticide in the form of an ointment and internally as an antiseptic and expectorant.

BALSAMUM TOLUTANUM—Balsam of Tolu

This is obtained from the trunk of *Myroxylon Toluiferum* H. B. & K. a tree very much similar to *M. Pereirae* (Royle) Klotzsch belonging to the same family. Its leaflets are thinner, membranous obovate and pointed, the terminal leaflet being larger than the others. It is a native of New Granada. Incisions are made on the trunk of the tree and the exudation is collected in gourds and exported as Balsam. It is a resinous substance which is soft and tenacious and has a fragrant aromatic odour and acrid taste.

History

Monardes of Seville, a Spanish physician, referred to Balsam of Tolu in 1574 as having being observed by the early explorers of South America to have been collected by the Indians by making incisions in the trunk of the tree. In December 1868 an Ornithologist by the name of Anton Goering travelling in Venezuela collected complete specimens of the plant. From his seeds plants were raised in England, Ceylon and Java.

Composition

Balsam of Tolu contains 12–15% free Cinnamic acid, 8% free benzoic acid, about 7·5% of an oily liquid and 80 % of resin.

Uses

It is used as an antiseptic and an expectorant and also to flavour sweets.

BASSIA

This consists of the seeds of *Bassia latifolia* Roxb., *B. longifolia* Linn. from Hyderabad, Ceylon and Madras, and *B. butyracea* Roxb. from the sub-Himalayan districts, trees belonging to the family *Sapotaceae*. *B. Longifolia* Linn. (S. *Mi ;* T. *Iluppai ;* Skt. *Madhuka*) is a very large tree, much branched with a thick furrowed yellowish-grey bark, the young parts being pinkish white. Leaves are alternate, linear-lanceolate tapering at both ends and crowded together on slender petioles. Flowers are pale yellow in small clusters appearing with the young leaves. Seed is solitary, ovoid with a short curved beak, linear hilum and thin brittle, shining, ochre-yellow testa.

History

Dr. Gibson in 1853 gave an account of *B. latifolia* Roxb. in Hooker's Journal of Botany as a tree from which flowers were collected both as an article of food and for the preparation of an intoxicating liquor which is detrimental

to the system. Ainslie mentions that the gummy juice which exuded from the bark of *B. longifolia* Linn. was used in South India as a cure for rheumatism. The bark was also used in the form of decoction as an astringent and a cure for itch.

Composition

Bassia contains 50–55% of fixed oil which is a pale yellow semi-solid with a characteristic odour and unpleasant taste. The seed carries poisonous substances which are left in the cake after the oil has been extracted.

Uses

The oil is used as an edible fat. It is used, after hardening, in the manufacture of margarine, soap, candles and as a substitute for cocoa-butter in chocolate manufacture. The cake, finely powdered, is employed as a fish poison and worm killer.

BELA—Bael

This consists of a dried or fresh half-ripe fruits of *Aegle Marmelos* Correa. (S. *Beli ;* T. *Vilvam, Vilva-pazham ;* Skt. *Vilva peshika*), a tree belonging to the family *Rutaceae*, cultivated in India and Ceylon. The tree possesses an erect trunk and an ash coloured bark bearing sharp strong axillary spines in pairs or singles. Leaves are ternate and the leaflets oblong or ovate-lanceolate. Flowers are pale greenish or white in colour, honey scented, bisexual and arranged in axillary or terminal panicles. Fruit is a large berry with a smooth hard shell which contains a large quantity of mucilaginous pulp in which the seeds are embedded. The dried sliced fruit is exported.

History

This is a sacred tree among the Hindus as an emblem of fertility. The Hindu physicians prescribed the fruit for cases of diarrhoea and dysentery. Garcia d'Orta, physician to the Viceroy of Goa in the 16th century mentions its efficacy in cases of dysentery.

Composition

The fruit contains a mucilage and pectin in the pulp.

Uses

Bael is used as a mild astringent and is a popular remedy for dysentery and diarrhoea. The ripe or mature boiled fruit may be eaten with honey for cases of piles.

BENZOINUM—Benzoin

This is a resin obtained from *Styrax Benzoin* Dryand (T. Shambirani). A tree belonging to the family *Styraceæ*. Its leaves are alternate, oblong, margin entire smooth above and tomentose below. Flowers are white, sweet smelling, occurring in axillary racemes.

The tree is induced to produce oleoresin ducts by injuring its trunk so as to damage the cambium. After sometime the liquid benzoin either accumulates between the bark and the wood or exudes from the incisions. This exudation is allowed to harden and exported in blocks.

History

The first mention of Benzoin occurs in the travels of Ibn Batuta between 1325 A. D. to 1329 A. D. and he mentions it as a product from Sumatra. Vasco da Gama who travelled extensively in the East in 1497 mentions its occurrence in Siam. Another Portuguese traveller found it along the Malabar Coast in 1511. England imported this commodity in the early part of the 17th century solely from Sumatra and Siam.

Composition

Benzoin contains esters of benzoic and cinnamic acids along with other free acids. In addition, the drug contains traces of benzaldehyde, vanillin, phenylpropyl cinnamate, styrol and styracin which together are responsible for its particular fragrance.

Uses

It is used as a carminative, expectorant and diuretic taken internally, and externally it acts as a stimulant and antiseptic.

BERBERIS

This consists of the dried stem of *Berberis aristata* D. C. a shrub of about six to eight feet indigenous to India and Ceylon. It belongs to the family *Berberidaceae*. Internally the stem is greenish yellow when freshly cut but turns brown on exposure to air. Its bark is smooth and pale while its twigs are elongated and glabrous. Leaves are simple but some of them are modified into sharp three branched leaf spines. Flowers are bright yellow occurring in drooping racemose panicles. Fruit is purple in colour, small, soft, smooth and two seeded.

History

The medical men of ancient Greece and Italy used a substance called Lycium brought from India for ophthalmic inflammations. This drug was also referred to by Dioscorides, Pliny, Celsus, Galen, and Scribonius Largus.

Composition

The chief constituents of Berberis are the bitter, yellow alkaloid Berberine, tannin, resin and other alkaloidal substances.

Uses

It is used as a tonic for intermittent fevers.

BETEL

This consists of the dried leaves of *Piper Betle* L. (*S. Bulath, Bulath-wel, Nagawalli ;* T. *Vettilai*, Skt. *Thambulam.*) A semiwoody climber belonging to the family *Piperaceae*, indigenous to and cultivated in India, Burma, Ceylon and Malayan Islands. The plant climbs by means of adventitious rootlets. It has a stout stem much thicker at the nodes. Leaves are large, six to eight inches in length, ovate, slightly cordate, shortly acuminate and acute at the apex ; margin entire or slightly undulate, seven veined shining on both sides. Petiole is about one inch in length. Flowers occur in dense spikes, the female spike being cylindrical and pendulous.

Leaves are picked when fresh, pressed, dried and exported in small packets.

History

The Betel leaf is considered as a symbol of respect by all Buddhists. It is mentioned in Buddhist scriptures and the plant is supposed to have a mythological origin. The Naga King Hiranthanan of the Naga World is said to have brought the leaf folded, holding it by the apex and base, between his teeth as an offering to Buddha. Hence the custom of breaking off the apex and the base of the leaf which parts are supposed to contain the venom of the cobra before it is used as a masticatory. Knox describes it as a plant " like Ivy, twining about trees or poles, which they (the Singhalese) stick in the ground for it to run up by. "

Composition

It contains a volatile oil made up of betel-phenol, chavicol, cadinene and various other sesquiterpenes.

Uses

It possesses antiseptic stimulant and carminative properties. The fresh leaf is widely used in India, Burma and Ceylon for Social invitations and greetings and as a masticatory. The Ayurvedic physicians employ it as a remedy for snake poison, tonsils and ear and eye affections.

BIXA

This consists of the seeds of *Bixa Orellana* Linn. A large shrub branched and spreading, belonging to the family *Bixaceae.* The plant, a native of Tropical America cultivated in the tropics, is easily distinguishable by its conspicuous pink flowers in clusters and crimson red spiny capsular fruits bourne at the ends of branches. Leaves are large, cordate peltate with long petioles placed spirally on rust coloured stems of branches. Flowers are pink, bisexual, radially symmetrical about two inches in diameter arranged in recemose inflorescences. The pedicels and peduncles are covered with rust coloured hair. The fruit is an ovoid crimson red capsule covered with fleshy spines on the outside. The seed has a triangular pyramid shape about 5 m.m. × 4 m.m. and a spongy crimson testa, the outer soft sticky resinous parts forming the Annatto dye of commerce.

The Annatto is separated by stirring the seeds vigorously with water, pulping, drying the pulped mass and pressing it into cakes.

Composition

Bixa contains bixin, a red crystalline colouring matter insoluble in water, fat and resin.

Uses

It is used as a dye for colouring silks and other fabrics, butter, cheese, waxes and varnishes.

BUTEA GUMMI—Butea gum

This is a dried resinous looking gum obtained from incisions made on the stems of *Butea frondosa* Roxb. (S. *Gas-kela ;* T. *Parasu or Parasang*) a moderate sized tree (Family *Leguminosae*) indigenous to India but also found in Ceylon towards Jaffna, Batticaloa, Bintenne, Bibile and in Burma. The tree is conspicuous owing to its crooked trunk and irregular branches. The leaf is trifoliate and leathery. The peculiar greyish colour of the tree when viewed from a distance is due to the silky covering on the undersurfaces of the older leaves. Flowers occur in stiff recemes, flame orange in colour but the outer surfaces of the petals take on a silky salmon pink colouration.

Composition

The chief constituent of the drug is Kinotannic acid.

Uses

It is used as a powerful astringent. The Ayurvedic physicians use the bark in the treatment of fractures and dislocations of bones.

BUTEAE SEMINA—Butea seed

This consists of the seeds of *Butea frondosa* Roxb. The seeds are reniform in shape and flat about 30 m.m. × 20 m.m. × 1·7 m.m. The testa is dark reddish brown, glossy, veined and wrinkled. Cotyledons are large leafy and yellowish. They have faint odour and slightly bitter taste.

Composition

Butea seeds contain 18 % fixed oil and 19 % albuminoid substances and sugars.

Uses

The seed is used as an aperient and anthelmintic and also as a remedy for ringworm.

(*To be continued*)

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A Study of the Conformation Characteristics of Sinhala Cattle

BY

P. MAHADEVAN

THE Sinhala cattle, which are characterised by their small size and stature and by the relatively poor development of hump and dewlap as compared with most other tropical and sub-tropical cattle, form the bulk of the cattle population of Ceylon. The fragmentary evidence available as regards their origin suggests that they are part of the remnants of a primitive breed which at one time populated Southern Asia, but which was later displaced by the larger forms brought in by human invaders. Isolation in Ceylon and the relative absence of large-scale importations of other stock have helped to perpetuate these cattle in this country. The purpose of the present article is to give a description of the conformation characteristics of this group of cattle.

SOURCE OF DATA

The herds on which the description of the conformation characteristics is based, are located at Karagoda Uyangoda and Ridiyagama in the Southern Province, and Nikaweratiya in the North-Western Province. The first of these herds has been in existence since 1937/38 but the other two are of comparatively recent origin. The coat colour which seems to have been stressed in the development of these cattle is black for the Karagoda Uyangoda and Nikaweratiya herds, while red Sinhala cattle are maintained at Ridiyagama.

THE MEASUREMENT OF CONFORMATION CHARACTERISTICS

Definite criteria for describing the conformation characteristics of cattle have hitherto not been established, so that it is difficult to decide on the type of data that would serve as a basis of comparison of the Sinhala cattle with well developed breeds in other countries. It is, however, clear that whatever method of description is used, it must be based on measurements selected as most nearly representing the skeletal size of the animal. Eckles and Swett (1918) were of opinion that " growth of the animal as far as the skeleton is concerned can be determined reasonably well by a few measurements and sufficiently well for most purposes by one measurement alone. " They selected height at withers as their measure of skeletal size. Brody (1927) suggested much the same thing when he stated that " since height at withers in cattle is but slightly influenced by environmental conditions, therefore at a given age the numerical value of this measurement is practically a genetic index of the size of the animal. " Lush and Copeland (1930) however, inclined to the view that a comparison of the conformation of animals belonging to different groups is difficult to bring out except in so far as it can be shown

through body proportions, or through the relation of each of the different body measurements to one or more measurements selected as representative of the skeletal size of the animal. They stated that "for most purposes a very few measurements considered in relation to each other or in relation to weight seem as much as would be really useful in contributing to the general picture of the animal and of the changes which occurred in it. Thus height over withers or over hips would certainly be included among those measurements least influenced by plane of nutrition, and therefore especially apt to be illuminating when considered in relation to weight."

It may also be mentioned here that some research workers have indicated that length of head rather than height at withers is the fundamental unit of measurement to which every other body measurement bears a definite ratio in the animal having the desirable form. Be it as it may, it is nevertheless evident that data presented in the form of ratios of one body measurement to another afford an opportunity to study conformation and comparative anatomy more or less irrespective of the size of the animals. The body measurements of the Sinhala cattle which are presented in this article appear in the form of both absolute measurements and ratios of the different body measurements to height at withers.

CONFORMATION CHARACTERISTICS OF THE SINHALA CATTLE

The figures presented in Table I were arrived at by weighing and measuring the adult cattle in the three herds mentioned earlier. For purposes of comparison corresponding figures based on a sufficiently large volume of data are unfortunately not available for other Tropical and Sub-tropical cattle, though some maximum and minimum figures and average measurements of animals typical of each breed have been published in India in an attempt to define the characteristics of some breeds of Indian cattle. For European breeds, however, adequate descriptions have appeared from time to time.

TABLE I

Body Measurements of Adult Sinhala Cattle

Item	*Black Sinhala Cattle*				*Red Sinhala Cattle*			
	♀♀		♂♂		♀♀		♂♂	
Height at withers (in.)	39.0 ± 0.18		42.8 ± 0.44		39.9 ± 0.26		41.3 ± 0.49	
Height at hips (in.)	39.0 ± 0.22		42.1 ± 1.22		40.4 ± 0.27		41.8 ± 0.42	
Ratio to height at withers	1.00		0.98		1.01		1.01	
Height at pin bones (in.)	35.7 ± 0.19		38.1 ± 0.75		33.3 ± 0.27		38.9 ± 0.36	
Ratio to height at withers	0.92		0.89		0.83		0.94	
Width at hips (in.)	12.8 ± 0.12		13.8 ± 0.27		14.1 ± 0.11		13.6 ± 0.31	
Ratio to height at withers	0.33		0.32		0.35		0.33	
Width at thurls (in.)	11.8 ± 0.09		12.9 ± 0.44		12.1 ± 0.15		13.6 ± 0.24	
Ratio to height at withers	0.30		0.30		0.30		0.33	
Width at pin bones (in.)	5.9 ± 0.09		6.0 ± 1.09		5.0 ± 0.07		5.5 ± 0.19	
Ratio to height at withers	0.15		0.14		0.13		0.13	
Live weight (lb.)	403 ± 6.12		566 ± 54.90		459 ± 8.63		636 ± 16.50	
Ratio to height at withers	10.33		13.22		11.50		15.40	
Heart girth (in.)	52.4 ± 0.29		59.0 ± 1.14		53.8 ± 0.43		58.0 ± 1.04	
Ratio to height at withers	1.34		1.38		1.35		1.40	
Length from point of shoulder to pin bone (in.)	41.1 ± 0.25		47.1 ± 1.94		42.4 ± 0.42		47.1 ± 0.99	
Ratio to height at withers	1.05		1.10		1.06		1.14	

If the measurements in Table I are compared with the published figures for European and Indian cattle, it would be observed that the measurements of the Sinhala cattle as expressed in absolute units are considerably smaller in every case than those of well-developed European and Indian breeds. This is a reflection of the extent to which the Sinhala cattle are dwarfed in absolute size. However, in spite of this great dimunition in size and stature, a remarkable similarity is found to exist in the body proportions of the Sinhala and Indian cattle when they are compared on the basis of ratios based on height at withers. The ratios for Indian breeds of cattle were worked out for this purpose from the available absolute measurements published in recent I. C. A. R. bulletins, and the results suggested very strongly that all tropical and sub-tropical cattle are fundamentally similar in skeletal structure irrespective of the breed to which they belong.

On the other hand, when the ratios of the Sinhala cattle are compared with the corresponding ratios for European cattle, it is found that while there is close similarity with respect to certain traits, wide differences exist as regards others. For example, the ratio of height at hips to height at withers in the present material shows more or less perfect agreement with the corresponding ratio for European cattle, while the ratio of height at pin bones to height at withers is about 0.83 to 0.92 for the Sinhala cows as compared with 0.97 to 1.00 for European breeds. But this, of course, is to be expected as it is characteristic of all humped cattle to have a sloping rump.

The ratio of the width measurements to height at withers appears to be smaller in the Sinhala cattle than in European breeds. These differences may be attributed, at least in part, to the degree of fleshing of the animals, so that it is difficult to determine the amount of reliance that should be placed on them.

As regards live weight it is interesting to note that the ratios to height at withers presented here are closely comparable to those reported for even such large cattle as Holsteins. But the ratios of heart girth to height at withers are about ten per cent. smaller in the Sinhala cattle than in Holsteins.

Perhaps the most interesting fact that emerges from the body measurements presented in this article is in relation to the ratio of length to height. The average value of this ratio is around 1.05–1.06 for cows in the present material as compared with 1.20 for European cows and 1.18 to 1.20 for Tharparkers in India. These figures suggest that the dwarfed size of the Sinhala cattle is attributable in greater measure to a reduced length than to a reduced height, though the latter is also very considerable. The two together explain most of the dimunition in size.

Comparison of the conformation characteristics of bulls and cows within the groups of Sinhala cattle studied, shows that although the bulls are about 40 per cent. heavier than the cows, the body dimensions are, on the average, not more than 17 per cent. greater. The greatest differences in body dimensions between males and females are in regard to height, length and heart girth. Nevertheless, the magnitude of the differences shows that despite the bulls being larger, the differences in neasurements do not approach the difference in live weight.

It may also be noted here that although the measurements of the black and the red Sinhala cattle are enumerated separately in Table I, it is difficult to say without other data, whether these two groups represent distinct types. Nevertheless, it will be observed that the Ridiyagama cattle show a close resemblance to the Karagoda Uyangoda and Nikaweratiya herds from the point of view of body proportions, though the former are slightly larger.

The average head measurements of the Sinhala cattle are set out in Table II so as to make this description of the indigenous cattle of Ceylon as complete as possible. In interpreting Table II however, a certain amount of caution is required as some individuals are polled, and therefore the measurements of length and circumference of horn do not have general application to all animals.

TABLE II

Head Measurements of Adult Sinhala Cows

Length of face from ocipital crest to upper ridge of muzzle (in.)	..	15.9 ±	0.11
Ratio to height at withers	..	0.41	
Width of face immediately above eye (in.)	..	6.9 ±	0.05
Ratio to height at withers	..	0.18	
Length of lower surface of ear from tip to junction of ear to face (in.)	..	6.9 ±	0.08
Greatest width of ear (in.)	..	3.8 ±	0.01
Length of horn (in.)	..	3.7 ±	0.39
Thickness of horn at base (i.e., circumference) (in.) ..	..	4.4 ±	0.08

SUMMARY

(1) A description is given of the conformation characteristics of the Sinhala cattle in terms of both absolute body measurements and ratios of the different body measurements to height at withers.

(2) While the absolute measurements of the indigenous cattle are considerably smaller in every case than those of well-developed European and Indian breeds, a remarkable similarity is found to exist in the body proportions of the Sinhala and Indian cattle.

(3) Comparison of the absolute body measurements of bulls and cows within the groups of Sinhala cattle studied, shows that while the bulls are about 40 per cent. heavier than the cows, the body dimensions are, on the average, not more than 17 per cent. greater.

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A Sinhala Bull

A Sinhala Cow

The Head of a Sinhala Cow

Part of a Herd of Sinhala Cattle

The Mango (Mangifera indica L)

BY

A. V. RICHARDS

INTRODUCTION

THE mango at its best is one of the finest tropical fruits of the old world. It is native to India and South East Asia where it has been grown for thousands of years. The great Moghul Emperors are known to have planted extensive mango groves, and one of the best varieties producing the biggest fruit is named after the Emperor Jehangir.

In South India there are large mango " topes " or orchards along the banks of rivers, but in Ceylon the trees are planted mostly in home gardens. Nevertheless, experimental plantings on orchard scale in the dry zone by the Department of Agriculture in recent years have shown promise, and as a result Island-wide interest is being taken in the commercial possibilities of mango cultivation in the dry-zone where land is readily available.

SOIL AND CLIMATIC REQUIREMENTS

Unlike many other fruit trees the mango will grow on a wide range of soils provided they are not too rocky, waterlogged, or shallow and infertile. It makes the best growth on deep, well drained, sandy loams, but for production of good crops the soil should not be very rich and clayey since the trees tend to run to leaf.

The mango is a tree of the plains, and its commercial cultivation is limited to elevations below 3,000 feet. Being a tropical fruit it is susceptible to frost damage. A long wet spell during blossoming period is detrimental to fruit set because of defective pollination and incidence of Anthracnose disease which causes the blossoms to shrivel up. Wet weather during ripening is harmful since it is liable to cause fruit rot and attract fruit flies.

VARIETIES

The mango—*Mangifera indica L*—belongs to the family Anacardiaceae which includes the cashew *Anacardium occidentale L* and Ambarella *Spondias cytherea* Sonn. There are several other species of *Mangifera* of which *Mangifera zeylanica—Etamba* is endemic to Ceylon. Although *Etamba* grows into a magnificent tree near water courses it is difficult to transplant and is too slow growing to be used commercially as a rootstock for mango.

Several hundreds of varieties of mango are known, but not many are of commercial importance. The best known commercial varieties are the Carabao and Pico in the Phillippines, Julie and Peter in the West Indies, the Kensington in Queensland, Haden in Florida, Sabre in South Africa,

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Netti in Burma, Mulgoba, Alphonso, *Neelam* and *Dilpassand* in India. The recommended varieties in Ceylon are the Jaffna (*Vellai colomban*), *Karutha colomban*, *Ambalavi*, Willard, *Neelam* and *Peterpassand*. The *Dilpassand*, which yields large attractive fruits, is highly productive in the Jaffna Peninsula where it grows to perfection under dry atmospheric conditions, but elsewhere the fruits tend to rot on the tree. The Rupee or *Polamba* is another variety producing large round fruits with delicious flavour which is commonly found in coconut estates in Kurunegala area. The trees take long to come into bearing and tend to crop in alternate years.

Many of the imported varieties such as Alphonso under trial in Ceylon have not been very productive and are not recommended for commercial planting. Their fruits are susceptible to internal breakdown under local conditions.

The Jaffna (*Vellai colomban*) mango is the most popular variety grown in Ceylon. Many of the trees in the wet zone are of seedling origin, but being from polyembryonic seeds in which the nucellar or vegetative embryos have developed at the expense of the sexual embryo produced by fertilization, thay have nearly all come true to type.

This variety is more tolerant of wet weather during flowering, and is able to set fruit more freely because of the relatively high percentage of perfect flowers in the inflorescence. In many of the shy bearing varieties such as Jehingir most of the flowers in the inflorescence are male flowers.

The fruits are of medium size, and do not develop an attractive colour on ripening, but the flesh is rich in colour, fibreless and of characteristic sweet flavour. It makes an excellent canned product. The *Karuthai Colomban* is another polyembryonic variety from Jaffna which is closely related to the *Vellai colomban* except that the fruits are slightly larger and develop an attractive orange red colour on ripening. The young foliage too is of darker green colour, and the trees grow into large size. This variety has done well on an orchard scale at Hingurakgoda where it produces a higher percentage of grade I fruit. Care is necessary in the selection of good strains since some tend to produce fibrous fruits in the wet season.

The Ambalavi is essentially a variety for the dry zone since the fruit fails to ripen properly in the wet areas. It has a prominent beak and acquires a reddish orange colour on ripening. Being mono embryonic, seedling trees show great variability and are generally inferior. The tree flowers more frequently than the other varieties and tends to produce two crops, the main one is May-June-July and the other in December-January.

The Willard is one of the few imported varieties which is highly productive in Ceylon. It was introduced from Mauritius by the late Sir Frank Stockdale when he was Director of Agriculture here. The tree is relatively small and ornamental in appearance. The fruits are medium small in size, and on ripening develop an attractive crimson blush on the side exposed to the sun. The flesh is firm, fibreless and very sweet in flavour. Unfortunately owing to the tendency of this variety to overbear a large

proportion of the fruits remain small, and are uneconomic to grade and sell. Fruit thinning has therefore to be rigorously practised soon after fruit set.

Neelam is a popular Indian variety which has been recently found to be productive both in the dry and wet zones. The fruit which is of medium size develops an attractive reddish orange colour on ripening, and is of excellent flavour and free from fibre. This variety is being multiplied for planting on a large scale.

Peterpassand is another Indian variety which has shown promise in the wet zone at the Experiment Station, Peradeniya. The tree bears regularly, but the fruits are inclined to be small and of yellow colour when ripe. The flesh is firm, fibreless and of delightful flavour.

PROPAGATION

Polyembryonic varieties such as Carabao, Netti, Jaffna and Kensington can be propagated from seed, but the seedling trees take long to come into bearing. Commercial propagation is best done by budding or grafting on sour (*Walamba*) or fibre (*Kohuamba*) mango stocks. The fibre mango being polyembryonic is preferable since the nucellar seedlings are all of uniform genetic make up for use as rootstocks. Budding by the 'H' method which is a form of the so called modified Forkert method gives good results both in the west and dry zones, but in the dry zone under irrigation cleft grafting is easier and gives high percentage 'take' on 3 to 4 months old seedling stocks.

In the 'H' method which is used successfully for the propagation of avocado, cacao, rambuttan and other fruits, with the exception of citrus for which the inverted T method is used, a horizontal cut and two vertical cuts in the form of an 'H' are made on the stock at a height of about 8 inches from ground level and the lower flap is peeled downwards and the upper flap slightly upwards. The scion bud-shield with the wood attached is cut from the current season's growth and held firmly in position over the panel made on the stock by replacing the peeled flaps of bark over it. The lower flap is trimmed back to expose the 'eye' of the scion bud. In the wet zone the scion bud shield is taken without the wood from the previous season's growth. The scion bud and the exposed tissues are tightly wound with good budding tape. Three weeks later the tape is unwrapped, and if the bud is green it is tied back leaving the 'eye' exposed. The stock is then cut back about 2 inches above the bud patch to force the scion bud to grow out.

Cleft grafting is relatively simple, and is done by inserting the lower end of the scion piece shaped as a wedge into a cleft made by cutting off the top of the stock. Care should be taken to see that the cambial surfaces of the stock and scion are in contact at least on one side. The budgrafting tape used for covering the exposed tissues is not removed till the scion has grown well. In the dry zone plantain fibre is used in place of budgrafting tape, and the scion piece is protected from sun scorch by tying two mango leaves round it.

Budgrafted trees are successfully established in bamboo pots after the tap roots have been severed *in situ* with a pruning secateur at a depth of about 9 inches six weeks in advance. Two cuts are made, and a piece of the tap root is removed before the soil mixed with leaf mould is put back to enable the cut end to calluse over and produce fibrous roots. This pre-treatment helps to reduce the shock of transplanting into pots.

Useless seedling mango trees in healthy vigorous condition are easily topworked to approved varieties by a method of sidegrafting developed recently (1).

PLANTING THE ORCHARD

Planting is best done with the early monsoon rains. Given an early start the young plants are able to stand the drought and produce good crops without irrigation. The spacing for most varieties is about 40 ft. × 40 ft., but Willard or *Ambalavi* which are relatively small could be planted closer at 35 ft. × 35 ft. Intercropping with Bombay cowpea, green gram and other leguminous crops could be carried out profitably for several years till the trees become crowded. Pruning is limited to removal of all stock growth, and light thinning out of the inside of the crown to let in more light and air.

MANURE

During the early years the trees may be given well rotted cattle manure at the rate of 4 to 5 baskets once a year, but trees in bearing may be given in addition bone meal at about 15 lb. per tree and wood ash at 10 lb. per tree.

HARVESTING AND GRADING

The main season for mango at Jaffna is from May to July or August with a small crop in December-January ; at Hingurakgoda from November-January with a small crop in June-July ; and in the wet zone from April to June. The fruits are graded according to size and best packed in single layer trays.

CONTROL OF PESTS AND DISEASES

The most serious pest of mango is the mango hopper with which is associated sooty mould. Trees severely attacked by the pest fail to set fruit. The pest is affectively controlled by dusting with a mixture of Gammexane and sulphur.

Anthracnose is a serious disease which attacks the inflorescence, young fruits and ripening fruits generally during wet weather. Spraying with Bordeax mixture (3–3–50) just before the flowers open, and again at weekly intervals twice or thrice is recommended as an effective control measure.

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DEPARTMENTAL NOTES

Notes on Systemic Insecticides

BY

H. E. FERNANDO

IDEALLY, systemic insecticides are compounds which exhibit the property of being taken up into a plant and translocated within its tissues sufficiently to exert insecticidal action against phytophagous insects. The use of systemic insecticides dates back to about 1935 when inorganic and organic selenium compounds and organic fluorine compounds like the methylals of fluoroethyl alcohol were employed as such. These compounds had serious disadvantages against their use, such as their marked phytoxicity, their high residual toxicity at harvest, and their prolonged residual action in the soil which prevented for many seasons the growing of cultivated crops on land treated with these chemicals.

Experiments by Schrader and Kükenthal led in 1940 to the discovery of the bis-dimethylamide of fluorophosphoric acid, but the mammalian toxicity of this compound was too high to permit its use as a systemic insecticide. In 1941, Schrader discovered the compond octamethyl pyrophosphoramide, known today as " Ompa ", " Schradan " and " Pestox ". This compound was found to be relatively less toxic to warm-blooded animals than the fluorine compounds, was detoxified in plants after some weeks and retained its residual toxicity in the soil for a limited period of time. Since the discovery of Ompa a number of compounds or mixtures thereof with similar properties have come to light, like " Hanane ", a mixture of bisdimethyl amino fluorophosphine oxide and bis-dimethylamino phosphorus anydride, and " Systox " which is a diethyl dithiophosphoric acid ester. All these new organophosphorus systemic insecticides are at present under intensive experimentation in many parts of the world and they offer some promise as weapons in man's fight against insects, particularly plant-sucking bugs which constitute a major group of insect vectors of plant diseases.

The new systemic insecticides belong to the group of organophosphorus compounds which includes compounds like parathion and tetraethyl pyrophosphate. These compounds while having marked insecticidal activity also have high mammalian toxicities and extreme precautions have to be taken in handling them. They are all nerve poisons and their toxic action is chiefly due to the inhibition of esterases especially the nerve enzyme cholinesterase which is almost universally present in the animal kingdom. Ompa which is intrinsically a poor inhibitor of cholinesterase is known to be converted in the plant tissues or the mammalian liver into a compound which is a strong inhibitor of cholinesterase. The cholinesterases of animals have been shown to vary considerably from species to species and research into the possibility

of obtaining organophosphorus compounds showing marked inhibitory activity towards this enzyme in specific orders families, or species of insects while at the same time having low mammalian toxicities, is being pursued intensively and on the results of such work will depend the greater applied value of the organophosphorus compounds as insecticides.

The fact that systemic insecticides are absorbed by and translocated within plant tissues makes it imperative that the residue hazard be very thoroughly investigated. In the case of Ompa it is known that toxic residues are very low about four weeks after treatment of the plant, depending of course on the dosage administered. Therefore after such a period of time has elapsed the consumption of harvested plants or plant products cannot cause acute poisoning. However, very little is known about the chronic effects of the long-term consumption of minimal residues of the toxicant or metabolites thereof found on such harvested plants.

Investigations in the Gold Coast on the control of the swollen shoot disease of cocoa, which is a virus disease borne by mealy bugs, have shown that Hanane offers promise of at least partially controlling this disease which threatens the country's cocoa industry. In practice capsules containing Hanane were inserted in the ground close to the stem of the tree. The Hanane was absorbed into the tree and high mortality of mealy bugs resulted for about six weeks. Further investigations on this problem are in progress at present. The Gold Coast Ministry of Agriculture has laid it down that Hanane will not be used on trees where beans are to be harvested for human consumption until the medical and agricultural authorities and cocoa manufacturers are satisfied that no trace of the original toxicity of Hanane remains in the cocoa bean at harvest time and that the keeping qualities and the flavour of the beans remain unaffected. At present therefore Hanane is used as a barrier treatment to contain the spread of the disease from infected areas. When all the trees in the barrier have shown symptoms of the disease they are removed and the spread of the disease is minimized.

While the new organophosphorus systemic insecticides offer definite promise against plant sucking and disease bearing insects their use has got to be approached with caution both on account of their high mammalian toxicites and the complex residue problems involved. It is only after very thorough investigations into the relative efficiency of these compounds as compared to other insecticides and careful examination of the hazards to man and domesticated animals involved in their use should any general recommendations be made.

Soil Conservation Notes: Land Slides

BY

R. MACLAGAN GOVRIE

WHEN the detailed Land Use Survey of the Kotmale villages affected by the landslides of August, 1947, was taken up it was assumed that this type of damage was confined to the Kotmale civil division. Within that area they were certainly common enough, for about 60 major slips occurred then in about 100 square miles of the main Kotmale valley. Many of these have since covered over with fresh pioneer vegetation and are now hardly recognisable, but many more are still open sores on the hillsides and potential sources of danger.

Possibly through the fresh interest which has been aroused through the discussion of the possibility of carrying through effective remedial measures in anchoring old landslips, a very large number of requests have been received asking for the examination of fresh slips. These are not by any means confined to Kotmale and are common all through the Kandy and Nuwara Eliya and Uva hills and it is now obvious that we are dealing with phenomena which are much commoner than is generally realized. A recent example is the 150-acre slip in Wegama, near Hewaheta, and a whole series of slips which threatened the Nuwara Eliya-Welimada road during the north-east monsoon in 1951-52.

1. *Causes.*—The essential causes of land surface movements are partly geological and therefore inevitable ; partly man-made and so to some extent preventable. Much of the tea and hill paddy of the hill districts is actually on a geological scree accumulated over many centuries along the base of the major cliff escarpments. This land has no stability other than its own weight holding it at an angle of rest. Anything that destroys that balance will initiate movement downhill, and amongst the causes one must count the following :—

(1) erosion of the surface soil leading to gullying ;
(2) the puddling of the surface or sub-surface layers through blocked drainage or heavy irrigation ;
(3) drainage from the cliffs and from land above them burrowing underground and emerging as springs or seepage further down the scree slope ;
(4) road cutting or widening which exposes an unsupported profile poised above the cutting ;
(5) kaolin or montmorillonite clay deposits derived from the rotting of certain types of highly metamorphosed rocks form a soapy lubricant, affecting gullies and stream banks to considerable depths ;
(6) impounding surface run-off in tanks or deep trenches may help to saturate an already unstable soil ;
(7) destruction or thinning out of the plant growth and tree roots which bind the surface soil onto deeper layers ;

2. *The types of movement* commonly met with can be summarized :—

A.—Slow Movements

(1) *Soil creep* is a lateral movement by mass deformation without any obvious slipping or opening of cracks. The rate of surface movement depends largely on the moisture content of the soil.

(2) *Earth flow* is a later stage of creep in which general movement on a hillside can be recognized by the bulging or earth-wave effect which often develops towards the foot of an unstable slope, with a corresponding sunken area towards the head of the area affected.

(3) *Surface or sub-surface slipping* with larger masses breaking away, depending largely on the inclination of the plane of movement, and the extent to which continuous ground anchorage of trees, &c., has been disturbed.

(4) Subsidence includes the caving or collapse of the surface when deeper layers have become hollowed out by deep-seated erosion. This is commonest in limestone, but by no means confined to it ; often found on patna land or on steep blocks of paddy land.

(5) *Rock creep* is when single isolated boulders at or near the surface of a scree shift by the pressure of their own weight on the unconsolidated material, usually debris, which supports them.

(6) *Talus creep* is a more general movement down the plane of a talus slope when the toe of this slope has been undercut and removed by bank erosion and river action, or by a road cutting, leading to the downward creep of the whole structure including the larger rocks buried in the deeper layers of the scree of talus.

(7) *Solifluction* is a special form of surface creep occurring where material of high moisture content is subjected to frost, the alternate freezing and thawing of the wet material giving rise to collapse of the puffed up soil pillars. This is not likely to give serious trouble in Ceylon except on a few clay road banks on the high passes, but it is a common enough feature of surface erosion in the wetter high patnas around Ambawela.

B.—Rapid Movements

Any of the above may speed up into major or at least spectacular movements and develop into one or other of the following types :—

(8) *Earth falls* are usually confined to steep undercut banks of streams, and to the collapse of sections of overhanging cliff faces which bring down much dry earth in their train.

(9) *Mud-flows* are common in enclosed drainage channels or deep gullies where normal sheet erosion debris is thickened up by addition from slumping banks, and the whole is swept out by the torrent until it reaches some more level platform where it spreads out, or forms a delta-shaped dump in the bed of the main river. Mud-flows also originate from the loose screes when subjected to heavy wash from cliffs or burnt patnas above. Newly burnt patna when hit by heavy rain it apt to carry off much heavy silt, and if this load is blocked or ponded back in a confined space in a narrow torrent bed, it will bank up until it bursts out as a major mud-flow. This was a very common type of damage in Kotmale and Maskeliya in Agust, 1947, when two consecutive days of torrential rain caused many mud-flows, which carried away some 60 houses and ruined many fields. More recent examples are at Halinna, near Opanake, and Wegama near Hewaheta.

(10) *Caving* is often associated with columnar or prismatic rock structure such as in the felspars of the Ceylon gneiss. It is the effect upon the surface when collapse on a small but deep and violent scale is revealed at the surface with tension cracks radiating from the main lines of cleavage in the deeper layers. In wet paddy the saturation of the overhang above a point of failure causes tension cracks along which further caving and slumping take place.

(11) *Slumping* is a wider spread failure by the downhill discharge of detached surface layers, leaving an obvious pattern of crescent-shaped lines of failure or cleavages. Such banks or " terracettes " usually have the horns of the crescent directed slightly downhill. Examples of this are clearly seen along the Nuwara Eliya-Welimada road. This caving or slumping is always preceded by undercutting and separation of the subsoil from the deeper rocks.

(12) *Rock fall or rock slide* is the rapid movement of newly detached portions of rock, either exposed bed rock or already separated groups of boulders, usually detached from an overhanging cliff.

(13) *Landslip or landslide* is used as a general term but I should prefer to restrict it to a major movement of material detaching itself suddenly from the parent rock. In high mountains it is often associated with snow avalanches, but in Ceylon it is more commonly linked with recent disforestation or the serious reduction of forest growth doing away with the previous root anchorage between the parent rock and the more superficial layers of soil and rotten rock. As the latter is the only " aquifer " or water-storing stratum, the loss of such material is most serious. In tea estates

completely bereft of shade trees during the recent enthusiasm to clear away all shade for fear of the blister blight, there is already an increase in movement of this sort, though usually confined to the unsupported fringes of tea above deep road cuttings.

(14) *Debris slide or avalanche* is usually confined to very steep slopes or scree surfaces which have become undermined by river bank cutting or road construction, or forced down from above by an overload of heavy snow or rock fall. It usually involves large masses of rock and boulder as well as soil and the rotted rock layer, so the track of its fall is deep and narrow, differentiating it from the landslip which often tends to spread out fan-shaped in its descent.

3. The cures can, like medical treatment, be divided into preventive, palliative and remedial.

A.—Preventive

(*a*) Preserve as much ground cover as is possible in catchments liable to slips ; forest is best ; good grassland is good, but burnt patna is bad.

(*b*) For big areas of grassland, introduce fire protection on the American forestry model—i.e., high lookouts to give cross-bearings on outbreaks, frequent truck roads for fire-fighting vehicles ; and afforestation to subdue the inflammable grass.

(*c*) Ensure effective drainage to the flanks and away from all vulnerable points such as new road cuts, and old screes.

(*d*) Get important or vital areas in the high hills brought under the Soil Conservation Act, No. 25 of 1951, under which strict rules can be framed to deal with these specific areas and misuse of land in them.

(*e*) Flood preventive measures such as water-holding dams throughout the more stable hill areas, e.g., Horton Plains.

B.—Palliative

(*f*) Reduce irrigation from slumping areas of irrigated paddy.

(*g*) Reduce resident population by transfer out of sore spots.

(*h*) Dig drains well uphill of any new slip so as to get the surface drainage away before it can get into the slip itself.

(*i*) Get a quick green plant cover established on any new earth slip. Even annuals from seed such as buckwheat or mustard or Crotolaria would help, also branch cuttings of Japanese sunflower, gasdul, gedumba, &c.

(*j*) Stabilise isolated threatening boulders by shoring them up with a concrete or masonry wedge. (The use of explosive to get rid of isolated rock is not recommended).

C.—**Remedial**

(*k*) Fencing and immediate afforestation of active slips, using "contour wattling" as a means of stabilising eroding surfaces during the period when the new green cover is establishing itself.

(*l*) Check-dams in torrent beds to reduce flood peaks and ensure more stable conditions in the minor streams, particularly those tapped for hillside irrigation.

(*m*) "Manicuring" of steep banks along the main stream beds, and planting up the flood plane area with dense flood-resistant material such as dwarf bamboo, rambuk reed grass, &c.

(*n*) Teach water conservation to paddy growers. Paddy should be grown with 4-acre-feet per crop instead of the present 20-acre-feet. Also teach the alternation of paddy with irrigated vegetables, to give the land a chance to dry out. And get a separate system of storm drains cut parallel to the irrigation inlet channels, so that storm water does not get mixed with irrigation unless it is needed as such.

(*o*) Improve the standard of tea cultivation and maintenance, particularly in poor small-holdings, to secure a better cover of tea itself, better water conservation to give heavier bush growth, and some shade trees. (Steep jungle rather than tea is the source of many rockfalls and landslips in time of exceedingly heavy and prolonged rain, but this is generally because the jungle above the tea has deteriorated or been wrecked for food production crops).

(*p*) Stone terracing for unirrigated hillside cultivation is the only sure way of making such cultivation permanently profitable and keeping the soil in place. (Stone walling on an active scree face is however not recommended; contour wattling is preferable).

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R. M. Gorrie

Improvement of Lime

BY

A. V. RICHARDS

TRIALS are in progress in connection with the improvement of lime by hybridisation with the early bearing Mindora and the Seedless Tahiti lime varieties. The seedling Mindora lime is a relatively small plant which is easy to grow in pots and comes into bearing within eight months. It grows into a straggly bush when planted on the ground and for its size is very productive in the early years. The fruits are somewhat elongated, thin skinned and contain more seeds than the country lime.

The seedless Tahiti lime is essentially a variety for the mid-country wet and semi-dry zones. It is short lived in the low-country. The flowers do not contain viable pollen, and no seeds are produced in the fruit except very occasionally when one or two seeds may develop through cross pollination.

The Mindora lime seeds are polyembryonic with two or more embryos in each seed of which one may be the sexual embryo developed from the fertilized ovule, and the others the nucellar embryos formed as vegetative buds from the nucellus, which consists only of maternal tissue. The sexual embryo is often smothered by the nucellar embryos in the early stages, and even if it survives it grows into a weak plant although in rare instances vigorous hybrid seedlings are not unknown to develop.

A suitable technique was developed to separate the embryos with their cotyledons intact under a dissecting microscope and germinate them in test tubes containing nutrient agar or on in petridishes containing moist filter paper placed over a layer of wet sand.

The cotyledons turn green within a week, and the radicle begins to clongate except in the case of the very small embryos which fail to grow. The healthy seedlings are pricked out into small clay pots and nursed carefully. A very large percentage of the seedlings are of nucellar origin and have the same genetic make up as the seed parent. The few hybrid plants that are produced are not easy to recognise in the early stages. They have to be studied in the field.

Papaw (Carica papaya L)

BY

A. V. RICHARDS

(Sinhalese : *Papol.* Tamil : *Papali.*)

THE papaw is native to tropical America from where it was taken to other tropical lands by Spanish and Potugese sailors. It is a fruit of high nutritive value, being rich in vitamins A and C, calcium and papain, a proteolytic enzyme which aids digestion.

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The tree is easily grown in home gardens and provides a regular supply of fresh fruit during the greater part of the year. But varieties which give high yields of papain are grown on a plantation scale solely for papain.

Papaw is very sensitive to water logging and will not stand poor drainage. A prolonged wet spell often results in death of trees on badly drained soils.

It is best grown from seed sown *in situ*. About 3 to 5 seeds are planted in " hills " made by excavating a hole 2 feet square and 1 foot deep, and filling it with good top soil and well rotted cattle manure. The seedlings are thinned out to one female or hermaphrodite tree per hole after they have come into flower. Seedlings could also be raised in plant supply baskets, but care has to be taken against losses by damping off. Transplanting from seed beds is often unsatisfactory as the plants take long to recover from shock.

VARIETIES

One of the best desert varieties is the Solo introduced by the Horticultural Division from Hawaii in 1940. It produces fruits of both round and pyriform shape, but owing to its tendency to overbear the fruits are inclined to be small. Fruit thinning is necessary with this variety to improve fruit size. Under favourable conditions the fruits colour attractively long before they become ripe. The flesh is relatively firm, very sweet and of exquisite flavour.

Bettina and improved Peterson are two varieties recently introduced from Queensland which are under trial. The former is a dwarf variety producing fairly round smooth fruits 3 to 5 lb. in weight and of attractive colour.

PLANTING

The trees may be spaced 10 feet to 12 feet apart both ways. They are generally shallow rooted, and being voracious feeders they respond to heavy manuring with organic manures such as well rotted cattle manure or blood meal. Liming is also very beneficial. The trees come into flower in 5 to 6 months from planting, and the fruits ripen in about 12 to 14 months. Seedling progeny of hermaphrodite trees is not all hermaphrodite. The tendency is for $\frac{2}{3}$rd of the progeny to be hermaphrodite and $\frac{1}{3}$rd female. The progeny of female trees pollinated by pollen from hermaphrodite trees tends to be about $\frac{1}{2}$ hermaphrodite and $\frac{1}{2}$ female. With the Solo variety it is best to discard all male trees and plant only hermaphrodite and female trees.

HARVESTING AND GRADING

Fruits should be harvested when fully mature and carefully packed in single layer trays or baskets padded with wood wool or straw. Bruising causes the fruit to rot. In Queensland the winter fruit is picked green and ripened in humid atmosphere at a temperature of 83° F. Humidity is maintained by boiling a kettle of water over a blue flame burner in a closed chamber.

MEETINGS

Rubber Research Institute of Ceylon

MINUTES OF THE 113TH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON MONDAY, MAY 19, 1952

Present.—Mr. W. A. Paterson, J.P. (in the Chair), Mr. W. P. H. Dias, J.P., Dr. A. W. R. Joachim (Director of Agriculture), Gate Muhandiram A. D. S. Jayasinghe, Mr. R. H. Wickremesinghe, C.C.S. (Controller of Finance and Supply) and Dr. E. J. Risdon (Acting Director R. R. I. C.).

An apology for absence was received from Mr. F. A. Ruck.

1. BOARD

The Chairman reported that :

(*a*) Mr. F. A. Ruck of Messrs. Carson Cumberbatch & Co. had been nominated to represent the Planters' Association of Ceylon during the absence of Mr. R. J. Hartley on furlough, as from April 14, 1952.

(*b*) The terms of office of Messrs. Montague Jayewickrema and C. Wijesinghe had been extended by the Minister of Agriculture and Lands until the election of members to the new Parliament takes place.

A letter of thanks from Mr. F. Amarasuriya in respect of the vote of thanks passed for his services as a member was read.

2. MINUTES

(*a*) *Confirmation.*—Draft minutes of the meeting held on March 10, 1952, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) *Matters arising from the minutes.*

1. *Experimental Committee and Smallholdings Committee.*—The following members were nominated to fill existing vacancies in the membership of the Experimental Committee :—

Messrs. W. P. H. Dias, R. J. Hartley and Gate Muhandiram A. D. S. Jayasinghe.

The Smallholdings Committee was revived and the following members were nominated thereto :—

Mr. W. P. H. Dias, Gate Muhandiram A. D. S. Jayasinghe and the Director.

2. *Visiting Engineer's Report.*—As recommended by the Visiting Engineer, the retention of a D. C. electricity supply was decided on and the purchase of a 160 KW. generating set was approved.

3. REPORTS AND ACCOUNTS

(*a*) Estate accounts for December, 1951, were tabled.

(*b*) Supplementary votes amounting to Rs. 43,550 were passed.

4. STAFF

(*a*) *Director.*—Reported that Dr. H. E. Young, Director, had gone on three months leave on March 27 and that Dr. E. J. Risdon, Chemist, was acting as Director with effect from that date.

(*b*) *Assistant Staff.*—Changes in staff since the last meeting were reported.

5. TECHNICAL MATTERS

R. R. I. M. Patent Policy.—The terms on which new processes patented by the Rubber Research Institute of Malaya may be used by rubber producers in Ceylon and certain other countries were noted.

6. LONDON ADVISORY COMMITTEE

Minutes of the 55th meetings of the Committee and the Technical Sub-Committee were tabled.

7. PUBLICATIONS

The following publications were tabled :—

(*a*) Combined 1st and 2nd Quarterly Circulars for 1951.

(*b*) Advisory Circular No. 33.

8. ANY OTHER BUSINESS

(*a*) *Conference of Scientific Officers at Bogor, Indonesia.*—Noted that Dr. H. E. Young, Director, and Dr. E. J. Risdon, Chemist, would attend the conference of Scientific Officers of Research Institutes to be held at Bogor, Indonesia, in mid July.

The meeting then terminated with a vote of thanks to the Chair.

C. D. DE FONSEKA,
Secretary-Accountant.

Dartonfield,
Agalawatta,
June 11, 1952.

RETURNS, &c.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED MARCH 31, 1952.

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to March 31, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and mouth	—	23	—	—	23	—
	Rabies	2	2	2	—	—	—
Colombo Municipality	Foot and mouth	38	170	—	—	132	38
	Rabies	3	16	16	—	—	—
Quarantine Station	Anthrax (in sheep and goats)	—	2	2	—	—	—
	Pleuro-Pneumonia	18	64	64	—	—	—
Northern Province	Anthrax	—	107	107	—	—	—
	Rabies	1	1	—	1	—	—
North-Central Province	Foot-and-mouth	—	1,015	22	—	969	24
North-Western Province	Foot-and-mouth	28	594	19	—	528	47
	Rabies	1	2	1	1	—	—
	Anthra	—	16	16	—	—	—
Central Province	Mange (cattle)	18	150	9	—	126	15
	Foot-and-mouth	26	350	—	1	342	7
Province of Sabaragamuwa	Foot-and-mouth	89	303	21	—	220	62
	Rabies	3	3	—	3	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva	—	—	—	—	—	—	—
Eastern Province	Foot-and-mouth	30	80	—	—	55	25
Southern Province	—	—	—	—	—	—	—

Department of Agriculture,
Peradeniya, Ceylon,
May 5, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED APRIL 30, 1952.

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to April 30, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	23	—	—	23	—
	Rabies	—	2	2	—	—	—
Colombo Municipality	Foot-and-mouth	8	178	—	—	170	8
	Rabies	4	20	20	—	—	—
Quarantine Station	Anthrax	2	4	4	—	—	—
	Pleuro-Pneumonia	17	81	81	—	—	—
Northern Province	Anthrax	—	107	107	—	—	—
	Rabies	—	1	—	1	—	—
	Black Quarter	84	84	84	—	—	—
North-Central Province	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	26	620	19	—	575	26
	Rabies	—	2	—	2	—	—
	Anthra	—	16	16	—	—	—
Central Province	Mange (cattle)	4	154	9	—	141	4
	Foot-and-mouth	79	429	—	1	378	50
Province of Sabaragamuwa	Foot-and-mouth	110	413	22	—	336	55
	Rabies	2	5	—	5	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva	Rabies	1	1	1	—	—	—
Eastern Province	Foot-and-mouth	250	330	20	—	100	210
Southern Province	—	—	—	—	—	—	—

Department of Agriculture,
Peradeniya, Ceylon,
May 30, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED MAY 31, 1952.

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to May 31, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	23	—	—	23	—
	Rabies	1	3	2	1	—	—
Colombo Municipality	Foot-and-mouth	—	178	—	—	178	—
	Rabies	5	25	25	—	—	—
Quarantine Station	Anthrax	—	4	4	—	—	—
	Pleuro-Pneumonia	12	93	93	—	—	—
Northern Province	Anthrax	—	107	107	—	—	—
	Rabies	—	1	—	1	—	—
	Black Quarter	33	117	117	—	—	—
	Foot-and-Mouth	202	202	—	—	164	38
North-Central Province	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Rabies	—	2	—	2	—	—
	Anthrax	—	16	16	—	—	—
Central Province	Mange (cattle)	11	165	9	—	145	11
	Foot-and-mouth	—	429	—	1	418	10
	Rabies	2	2	—	2	—	—
Province of Sabaragamuwa	Foot-and-mouth	15	428	22	—	406	—
	Rabies	1	6	—	6	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva	Rabies	2	3	2	1	—	—
Eastern Province	Foot-and-mouth	166	496	27	—	326	143
Southern Province	—	—	—	—	—	—	—

Department of Agriculture,
Peradeniya, Ceylon,
July 1, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, APRIL, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·5	+0·9	74·9	+0·4	70	93	5·4	8·30	17	+ 1·87
Badulla	83·3	—0·8	66·7	+0·5	78	97	6·4	14·15	25	+ 7·15
Batticaloa	88·3	+0·5	76·8	+0·1	80	95	5·4	1·03	5	— 1·27
Colombo	88·4	+0·5	75·3	—0·6	77	95	6·4	8·30	23	— 0·77
Diyatalawa	78·6	+0·9	61·4	+0·9	79	94	7·0	11·88	28	+ 5·34
Galle	86·3	+0·2	76·3	—0·4	78	91	6·2	7·01	18	— 1·70
Hambantota	87·3	—0·4	76·0	—0·3	78	91	5·0	3·29	11	— 0·57
Jaffna	90·6	+1·1	80·5	+0·3	72	82	4·6	2·21	10	— 0·02
Kandy	88·4	+0·1	70·1	+0·1	73	95	6·2	11·17	25	+ 4·68
Kankesanturai	92·1	—	78·8	—	69	89	4·7	1·54	5	—
Kurunegala	91·3	+0·3	74·5	—0·2	71	90	5·8	17·95	24	+ 8·04
Mannar	91·7	+1·4	78·1	+0·1	72	89	5·4	1·28	9	— 2·14
Nuwara Eliya	71·3	+0·1	52·0	+2·3	80	94	6·6	8·04	19	+ 3·06
Puttalam	90·3	+1·1	76·1	0	72	91	5·3	3·77	11	— 1·11
Ratmalana	87·9	—	75·3	—	76	93	6·2	8·71	19	— 1·86
Ratnapura	92·4	+1·3	73·4	—0·4	77	95	6·6	19·57	25	+ 8·00
Talawakele	77·5	—0·1	58·7	+1·0	84	94	5·2	8·08	22	+ 1·78
Trincomalee	88·4	—0·8	77·3	—0·3	72	89	5·6	2·51	6	+ 0·38

WEATHER SUMMARY, APRIL, 1952

A regular feature of the weather in April was the occurrence, almost daily, of afternoon or evening thunderstorms in the south-western parts of the Island. They were also experienced in the north-central and north-eastern parts, but less frequently. The accompanying rain was moderately heavy, in the south-west on the 14th, and among the hills on the 19th and 28th.

In the south-west and the hill-country, monthly rainfall ranged generally from 10 to 20 inches, but larger totals were registered in the Kalani Valley District and on the Balangoda and Haputale Hills, the highest being 44·87 inches at Lemas Estate, 42·51 inches at Marambekanda Estate, 41·06 inches at Meeriabedde Estate and 37·00 inches at Lunugala Estate. These totals were more than double the average for the month. In the Northern Province and in Batticaloa District the weather was mainly warm and dry, rainfall recorded being only of the order of 2 inches.

Rainfall was above normal over a large portion of the Island, the greater excesses of 5 inches and over, occurring in the hill-country and neighbourhood. Outstanding excesses were 27·74 inches at Lemas Estate, 27·44 inches at Marambekanda Estate, 24·83 inches at Meeriabedde Estate and 21·50 inches at Lunugala Estate. Deficits, generally small, occurred mostly in the coastal area, the biggest being 6·45 inches at Moratuwa and 4·48 inches at Hunumulla.

Although the monthly rainfall in some regions was unusually high, there were only 6 daily falls over 5 inches. The highest was 6·18 inches at Tangalla on the 3rd.

Temperatures were, on the whole, a little above normal, both by day and by night. The highest temperature recorded during April was 95·2° at Anuradhapura on the 25th, while the lowest temperature for a low-country station was 70·9° at Ratmalana on the 25th and for the whole Island 46·4° at Nuwara Eliya on the 6th. Day humidity varied from 70 to 80 per cent. and night humidity from 85 to 95 per cent. Skies were more cloudy than usual, while the wind strength was little below average.

A. P. KANDASAMY,
Acting Director,

METEOROLOGICAL REPORT, MAY, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·6	+1·8	77·4	+1·1	66	89	5·8	0·61	7	— 2·93
Badulla	84·3	—1·1	67·2	+0·8	76	95	6·3	4·62	16	— 0·07
Batticaloa	91·0	+0·8	78·2	+0·4	77	91	5·2	0·79	1	— 1·00
Colombo	87·4	+0·4	77·6	0	81	91	7·0	12·05	26	— 3·44
Diyatalawa	77·1	—1·5	63·2	+1·2	78	87	6·8	11·55	23	+ 5·49
Galle	85·6	+0·6	78·4	+0·3	82	86	6·4	11·77	26	— 0·90
Hambantota	86·7	—0·1	77·6	+0·1	83	91	5·7	6·01	14	+ 1·74
Jaffna	89·1	+1·0	82·8	+1·2	76	81	5·3	1·36	3	— 0·64
Kandy	85·6	—1·6	71·1	+0·1	78	92	6·7	16·08	19	+ 8·51
Kankesanturai	92·3	—	81·6	—	70	83	6·2	2·44	4	—
Kurunegala	88·4	—0·8	76·3	+0·3	74	86	6·1	12·07	20	+ 4·52
Mannar	91·1	+0·6	81·4	+0·7	76	85	6·2	0·57	1	— 1·22
Nuwara Eliya	68·4	—2·0	54·2	+1·1	85	94	7·1	27·26	25	+18·79
Puttalam	90·0	+1·8	79·9	+1·1	74	87	6·0	1·07	8	— 2·70
Ratmalana	87·2	—	77·9	—	79	91	6·8	12·61	27	— 3·80
Ratnapura	88·2	—0·7	75·2	+0·3	83	95	7·0	24·68	29	+ 3·77
Talawakele	74·5	—1·1	59·9	+0·2	90	97	6·0	22·93	22	+13·52
Trincomalee	92·1	+0·1	79·8	+1·1	66	80	5·8	1·85	4	— 1·38

WEATHER SUMMARY—MAY, 1952

The main feature of the weather in May was the occurrence of active south-west monsoon conditions during the second half of the month, with overcast skies, strong south-westerly winds occasionally reaching gale force and frequent rainsqualls in the south-western parts. Commencing on the 19th these conditions continued till about the end of the month. During this period the rainfall on the south-western slopes of the hills was persistently heavy, daily measurements generally exceeding three inches. On account of these heavy rains floods were experienced in the three major rivers, Kelani-ganga, Kalu-ganga, and Mahaveli-ganga, while rail and road traffic up-country was disorganised by earth-slips. A certain amount of damage to house and property was caused by the strong winds.

During the first half of the month too some rain was experienced, (as a result of afternoon or evening thunder activity), which was also confined to the south-western parts.

Consequently, the monthly rainfall was considerably high on the south-western slopes of the hills, several stations aggregating totals exceeding 40 inches. The highest were 50·20 inches at Watawala, 49·88 inches at Massena, 49·71 inches at Norton Bridge, 48·86 inches at Kenilworth Estate and 48·78 inches at Blackwater Estate. These totals were more than double the average for the month. Outside this are a there was a gradual decrease in rainfall, the totals at the south-western coastal stations ranging from 10 to 15 inches only. In the north and the east the weather was mainly bright. Least rain was experienced in the north-western parts and in the Eastern Province, where the totals were below 2 inches.

Greater excesses, exceeding 20 inches, occurred among the central hills, the highest being 28·34 inches at Kabaragalla Estate, 24·46 inches at Watawala, 26·06 inches at Labookelle Estate and 25·40 inches at Nawalapitiya. In the south-western mid-country also the rainfall was appreciably above normal, while in the adjacent areas towards the coast it was appreciably below, the biggest deficits for the month occurring in Kalutara District, viz., 10·71 inches at Galagoda Estate, 9·12 inches at Sirikandura Estate, 6·80 inches at Kanana Estate and 5·67 inches at Gikiyanakanda Estate. Other regions in which deficits occurred were the North-Western Province, the North-Central Province and the Eastern Province.

There were 64 daily falls over 5 inches in May, a majority of them occurring on the 20th and 24th. The highest were 8·15 inches at Massena and 7 65 inches at Gona Penigala Estate, both on the 20th.

Day temperatures were well below normal up-country and well above normal in the north, while night temperatures were above normal generally. The highest temperature recorded during May was 97·4° at Trincomalee on the 1st, while the lowest temperature for a low-country station was 72·5° at Batticaloa on the 20th and for the whole Island 43·9° at Nuwara Eliya on the 9th. In the dry zone the mean day humidity varied from 65 to 75 per cent. and in the wet zone from 75 to 85 per cent. The mean night humidity varied generally from 85 to 95 per cent. Skies were more cloudy than usual, particularly during the second half of the month. Wind strength was above average, prevailing direction being south-westerly.

A. P. KANDASAMY,
Acting Director.

7——J. N. B 18602 (7/52)

METEOROLOGICAL REPORT, JUNE, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·7	+3·0	77·2	+0·8	59	86	5·0	0·01	1	— 0·72
Badulla	85·2	—0·1	66·0	+0·6	66	95	5·7	0·86	6	— 0·68
Batticaloa	93·1	+0·8	78·5	+0·8	68	82	5·4	0·53	4	— 0·36
Colombo	85·2	—0·2	77·2	—0·1	83	89	6·8	8·54	25	— 0·12
Diyatalawa	78·2	+0·7	63·7	+0·4	64	82	6·6	1·49	7	— 0·47
Galle	83·4	—0·2	76·9	—0·3	84	88	6·7	5·86	24	— 2·58
Hambantota	86·3	0	77·1	+0·3	80	88	5·7	1·43	9	— 0·68
Jaffna	86·7	0	81·4	+0·5	78	83	5·3	0·05	1	— 0·34
Kandy	83·1	—0·1	71·5	+0·3	80	88	6·6	6·41	27	— 2·42
Kankesanturai	90·9	—	81·0	—	69	82	6·2	0·72	1	—
Kurunegala	86·5	0	75·8	+0·2	76	88	5·8	2·38	26	— 4·41
Mannar	88·7	+0·5	81·1	+0·5	76	85	5·9	0·04	1	— 0·32
Nuwara Eliya	65·8	+0·3	56·6	+0·9	88	91	7·9	9·63	27	— 0·80
Puttalam	87·7	+1·5	79·8	+0·6	74	85	5·8	0·21	5	— 1·19
Ratmalana	84·8	—	77·1	—	82	89	6·4	9·94	24	+ 0·96
Ratnapura	86·8	+0·2	75·0	+0·3	82	95	7·0	14·70	28	— 3·85
Talawakele	71·2	+0·6	61·3	+0·9	92	94	7·8	15·02	29	+ 1·74
Trincomalee	93·7	+1·5	79·7	+0·6	58	76	6·3	0·00	0	— 0·93

WEATHER SUMMARY, JUNE, 1952

Normal monsoon weather with cloudy skies and south-westerly winds prevailed over the Island in June, rainfall being mainly confined to the south-western parts. Although rainfall was expereinced in these regions practically every day, there were no abnormally high daily falls. Greatest monthly totals occurred in the south-western hill country, Watawala aggregating 33·50 inches for the month, Norton Bridge 33·33 inches, Blackwater Estate 32·31 inches and Kenilworth Group 32·21 inches. From this region the rainfall decreased gradually towards the west, monthly totals in the south-western coastal areas ranging only from 5 to 10 inches. Warm and dry weather prevailed in the north and the east, as many as 90 stations sending in nil reports.

Rainfall was below normal throughout the Island. Larger deficits, of the order of 5 to 10 inches, occurred in the south-western hill country and neighbourhood (the region that gets the highest rainfall in June viz., 10·27 inches at Theydon Bois Group, 9·91 inches at Kitulgala, 9·31 inches at Dabar Estate and 8.49 inches at Hapugastenne Group. There were a few isolated slight excesses, the only appreciable one's being 5·19 inches at Kehellandewewa, 2·71 inches at Dandagamuwa and 2·20 inches at Tirrukovil Estate.

There were no daily falls over 5 inches in June.

Temperatures were above normal, both by day and night. The highest temperature for the month was 98·2° recorded at Batticaloa on the 30th. The coldest night in June was on the 27th, the lowest temperature for the month at several stations occurring on that day, including 70·9° at Ratnapura, the lowest for a low-country station, and 51·8° at Nuwara Eliya the lowest for the whole Island. Day humidity ranged from 60 to 80 per cent. in the dry zone and from 80 to 90 per cent. in the w zone, while night humidity ranged generally from 80 to 95 per cent. Cloud amounts were above normal, and wind strength about normal, the prevailing direction of wind being south-westerly.

A. P. KANDASAMY,
Acting Director.

Registered as a Newspaper in Ceylon

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JULY TO SEPTEMBER, 1952
(3rd QUARTER, 1952)

The Tropical Agriculturist

The Agricultural Journal of Ceylon

Founded in 1881
by the late Mr. John Ferguson, C.M.G.

Published by
The Department of Agriculture
Peradeniya, Ceylon.

Time to Tackle

H. MARIONI

You can now confidently battle with that pest of so many growing crops—the Root-knot Eelworm.

SHELL D-D SOIL FUMIGANT is the weapon you require. It has stood the test of many trials and has come out triumphant from each contest.

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The Late Rt. Hon. D. S. SENANAYAKE

Minister of Agriculture and Lands, 1931-1947

and

Prime Minister of Ceylon, 1947-1952

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The

Tropical Agriculturist

July to September, 1952

EDITORIAL

Assistance to Smallholders in the Plantation Industries

DURING the years following the introduction of the Donoughmore Constitution, Government has directed its land policy mainly to the development of Crown land under irrigation, colonization and settlement schemes with the primary object of increasing food production in the Island. This farseeing policy adumbrated by our late Prime Minister, the Right Hon'ble D. S. Senanayake, when Minister of Agriculture and Lands, has resulted in an appreciable increase in the extent of land cultivated with food crops, chiefly paddy. But Government's attention was not directed towards this channel only. Realizing that the plantation industries contribute very appreciably to the economic well-being of the country and that the smallholders have some part to play in our plantation economy, it decided that all new planting of rubber in the Island should be undertaken almost entirely by middle-class lessees and landowners and by smallholders. Government was also insistent that the tea and coconut smallholders should derive the benefits of the results of research carried out on these crops. Any move on the part of the Research Institutes of the major economic crops of the Island which concerned the improvement of the condition of smallholdings and their rehabilitation received, therefore, its strongest support.

When it is considered that nearly 12 per cent. of the 560,000 acres of tea in this Island consists of smallholdings, that approximately 25 per cent. or over 170,000 acres of the 655,000 acres of rubber land are owned by smallholders—a small holding in each case being considered to be one of less than 10 acres extent—and that no less than 70 per cent. of the million odd acres of coconut land are in smallholdings of less than 20 acres extent, the importance of this large community of agriculturists whose welfare is so intimately connected with these plantation crops begins to be apparent. Accordingly, during recent years, the Boards of Management of the Research

Institutes have in accordance with Government's policy in regard to assistance to smallholders, done a great deal to promote the well-being of this class of cultivators. Each of these major industries has now a Small Holdings Advisory Service in charge of a special officer to direct its activities. These officers are assisted by an extension staff whose activities are concerned entirely with smallholders. On each of the Research Boards representatives of the smallholders find a place, and they bring to the knowledge of the Board the particular problems relating to their respective smallholders.

In this issue of *The Tropical Agriculturist* the Small Holdings Officers of the Tea, Rubber and Coconut Research Institutes present a survey of the activities and functions of their respective schemes. It may here be pertinent to review the type of assistance which smallholders of these industries now receive. Under the tea smallholder's scheme, tea planting material and green manure seed are readily made available to smallholders, instruction is given by Tea Instructors during their inspections of smallholdings on methods of pruning, manuring and plucking tea, and assistance is rendered on the tracing of roads, drains and contour lines, and on soil conservation measures generally. Demonstration holdings are also sponsored in each district and steps are being taken with the co-operation of the Agricultural Department to establish model plots on some of our farms. The Tea Small Holdings Advisory Service is largely maintained by a special cess. Measures are under consideration by Government for further assistance to tea smallholders through the agency of Co-operative Societies.

In rubber, the Small Holdings Service is partly financed by a grant from Government for the maintenance of what is now known as the New Rubber Planting Scheme. The Small Holdings section has, as its main function, the rendering of free assistance and advice to smallholders regarding matters connected with the cultivation, maintenance, manufacture and marketing of the crop. Practical demonstrations are conducted in rubber tapping, budding, disease control, sheet making, &c., and holdings are lined for contour drains as a measure against soil erosion. On new planting permit areas grants are paid when the drains have been completed. Large quantities of approved high yielding material are also supplied free to smallholders. These consist of clonal seedlings as well as budded stumps of approved clones. The clonal seed nurseries are planted by and are under the supervision of the Department of Agriculture. Proposals are now being considered by Government for a replanting subsidy scheme in which not only rubber smallholders but also large estates could participate.

The Coconut Small Holdings Scheme, considering the large extent owned by smallholders is, perhaps, the least advanced of the three. But through the agency of Co-operative Societies many smallholders have been able to take advantage of the facilities which the Scheme offers them. Coconut seedlings from selected seed nuts for replanting purposes are made available to members of Co-operative Societies at a considerably reduced rate. The work of the officers of the Coconut Advisory Service is largely concerned with the giving of advice and practical demonstration to coconut

growers on modern scientific methods of coconut cultivation based on the results of experiments and investigations. It is also proposed to establish shortly demonstration plots in the various districts where smallholders could see for themselves, how, by the adoption of these methods of cultivation, results of considerable benefit to themselves and to the industry in general could be obtained. A scheme for the systematic rehabilitation of the industry through replanting and improved cultural methods over a period of years is under consideration by the Board of the Coconut Research Institute for submission to Government shortly.

There is little doubt that with increased labour costs the plantation industries will have, in the years to come, to rely more largely on the smallholders, at any rate in the case of rubber and coconuts. It is therefore incumbent on all those concerned with the plantation crops that the smallholders should be trained to realise their responsibilities towards these industries which are of such vital importance to the economy of the country. Government on its part will no doubt, more so even than in the past, view sympathetically any scheme submitted for its consideration which will be directed towards the amelioration and rehabilitation of the smallholdings of our major economic crops.

ORIGINAL ARTICLES

Tea Small Holdings Advisory Service

BY

R. L. ILLANKOON

ALTHOUGH the primary function of the Tea Research Institute is research on the culture and technology of tea, advisory work must inevitably come within the scope of its activities. The result of research are of little value unless they are translated into practice.

The benefits of research are passed on to estates through advice given by research officers who are thus kept in touch with practical realities. In dealing with an average estate the advice is applied to several hundred acres ; and when agency houses or visiting agents are concerned the area involved is much greater. The Tea Quarterly also plays an important role in disseminating advice and information.

The position with regard to small holders is quite different. In the first place, the small holder seldom seeks advice, and in the second, advice given to a small holder covers less than 20 acres at a time—often only a fraction of an acre. Clearly, therefore, an extensive service to cater to the needs of small holders is essential.

For some years the Tea Research Institute employed three Small Holdings Officers but the task of dealing adequately with sixty thousand acres of scattered holdings proved to be an impossible one.

The Tea Research cess was recently increased by five cents in order to provide more funds for an adequate extension service.

The figures quoted below are taken from the Census Report of 1946, of units below 20 acres in tea in the tea growing provinces of Ceylon. Considerable acreages have since been added by the opening of new clearings.

	Acres
Central Province	38,036
Southern Province	14,313
Province of Sabaragamuwa	15,055
Province of Uva	7,386
Western Province	1,904
North-Western Province	284

The distribution of small holdings in the provinces shows how widely scattered they are. Even with the increased staff it would seem a difficult task to give all the attention and advice that Small Holders require.

The success of the scheme must depend on how much enthusiasm and keenness can be instilled into these Small Holders, who have, hitherto not had the benefit, due to lack of staff, of concentrated advisory work.

Once this enthusiasm and keenness is created, and work is conducted on proper lines, Small Holders realizing the benefits of this scheme will continue to maintain progress. I therefore advise the concentration of our activities in limited areas, for it is only by this means that it would appear possible to ensure some measure of success.

This concentrated effort would eliminate much waste of time on those who are not interested in improving their tea holdings. By thus working within a smaller compass, officers could hope for quicker results than would be the case if they were put in charge of widespread areas.

It has been found from experience that money and time has been spent on travelling, rather than on advisory work, when large areas have to be covered. There is, however, an exception to this in the Central Province—Kandy District—where Holdings owned by different Small Holders adjoin each other and larger acreages could be worked by any single officer. It is clear from the reports of officers that they are unable to visit more than four holdings a day owing to the long distances by which their holdings are generally separated. It is, in my opinion, very necessary that four Provincial Officers be stationed in those provinces where there are the largest number of Small Holdings.

Though an officer will be stationed in a province he cannot be held responsible for all the detailed work of the province, as the area would be too big. I propose that he personally be made responsible for a particular area, either a D. R. O's division, or one whole D. R. O's division and part of another (*i.e.* Korale), depending entirely on the density of Small Holdings. This officer's main duty would be to concentrate on the particular area allotted to him but as a subsidiary duty he should supervise the work of Junior Officers or Instructors.

Though a D. R. O's division may seem small, one must not lose sight of the number of small holdings in a particular division. There may be as many as 4,000 to 5,000 holdings in some divisions.

From past experience it has been amply proved that, by stationing officers in provinces, without allocating to them a definite working area, large sums of money have been spent on paying travelling claims and very little work done. The officers responsible cannot be blamed for this state of affairs, as the areas allotted to them have been too large. When areas are too large, any advice given on a particular visit is not followed up with subsequent visits at short intervals, and is often, therefore, of little real benefit to the Small Holder.

After a period when it is found that progress in an area where a Provincial Officer has been working is satisfactory, a Tea Instructor can take over from him, thus releasing the senior officer for work in fresh fields.

The work of the Instructors in these areas would be simplified by the pioneer work done by the more experienced Provincial Officers. Further, at the end of this period the area should be studded with demonstration plots, worked entirely by the Small Holders with very little assistance from the Institute. The work on these demonstration plots should be an inspiration to those Small Holders who have missed an opportunity offered them earlier and who may now make good.

The Headquarters of the Small Holdings Advisory Service is situated at Augusta Road, Peradeniya.

The principal tea growing areas have been staffed in the following order under the new scheme :

Central Province	2	Small Holdings Officers	5	Tea Instructors
Southern Province	1	do.	2	do.
Province of Sabaragamuwa	1	do.	2	do.
Province of Uva			1	do.

One Cinema Operator, Cum Tea Instructor.

These officers have now been allotted definite working areas in the various provinces. Their main duties are to visit Small Holdings and advise and assist them on the modern methods of Tea cultivation. Assist them with their pruning, by supervising and demonstrating to them the best methods. Help them with the opening of new lands in Tea on the contour system which involves considerable work, in tracing of roads, drains and contour lines for the planting of tea.

Planting materials, such as tea seed, green manures are readily made available to Small Holders as considerable difficulty is found in obtaining good tea seed and planting materials.

Besides this expansion of staff, the Advisory Service is equipped with a Propaganda Film Unit so as to be able to provide instruction through the visual medium to Small Holders whose resolve and taste for studying literature on modern agricultural methods may be small and limited.

The Film Unit visits all the tea growing areas in the Island in rotation and supplements the propaganda work done by the officers. This has proved to be a most helpful medium of instruction and has made the task of these officers very much easier.

These Instructors, in my opinion, should be our future Senior Officers and this system would afford them an opportunity of taking a greater share of responsibility.

The Small Holdings Department of the Rubber Research Institute of Ceylon

BY

W. I. PIERIS

ORIGIN AND DEVELOPMENT

THE Smallholdings Department came into existence as the result of a realization on the part of the Board of Management of the Rubber Research Institute in 1935 that, although large estate owners in Ceylon derived considerable help and benefit from the work of the Institute, there were no facilities whatever to make these benefits available to the small owner. This seemed unreasonable both in view of the fact that small owners possessed an appreciable proportion of the Island's Rubber and contributed the same cess for the maintenance of the Institute as the larger owner.

In September 1935 a technical officer of the Institute (Mr. W. I. Pieris) was sent on a two-months' visit to Malaya to study the Smallholders' Advisory Service of the Rubber Research Institute of Malaya prior to inaugurating a similar service in Ceylon. A start was made with the appointment of two Rubber Instructors at Matugama and Horana in November 1936 to help and advise smallholders of the district and of a Clerk-Translator to attend to clerical work and translate advisory leaflets. As a result of the useful work done by these two Instructors, four additional Instructors for Galle, Kelani Valley, Kandy and Ratnapura were appointed in 1938 and four more for Kegalla, Gampaha, Akuressa and Elpitiya ranges between 1941–1946, making a total field staff of ten. An Assistant Propaganda Officer was appointed to the Department in 1947 to ensure the closer supervision of work in the ranges.

In October 1948 the entire work of the New Rubber Planting Scheme, which was an organisation of considerable magnitude, was taken over, resulting in the staff being increased to a Small Holdings Propaganda Officer, 3 Assistant Propaganda Officers, 4 District Field Officers, 31 Rubber Instructors, 4 Clerks and 2 Peons. At present the Department consists of 46 officers.

FUNCTIONS AND SCOPE

The principal function of the Department is to render free assistance and advice to Rubber Smallholders regarding matters connected with the cultivation, maintenance, manufacture and marketing of rubber. These services, which were previously confined to owners of mature plantations and

replanters, were considerably increased with the taking over of the New Rubber Planting Scheme in 1948, when an additional 50,000 acres (approx.) of young new-planted rubber, mostly budded, came under the special purview of this Department.

There are approximately 655,000 acres of rubber in Ceylon, of which 168,000 acres is in smallholdings of below 10 acres and a further 141,000 acres of small estates of 10–100 acres. The needs of all the 168,000 acres of smallholdings and part of the 141,000 acres of small estates are catered for by the Smallholdings Department. For 1950 approximately 51,000 acres out of the total 655,000 acres in Ceylon consisted of budded rubber, the bulk of which, namely about 39,000 acres, are small estates (10–100 acres) and smallholdings (less than 10 acres) planted under the New Rubber Planting Scheme. Most of these receive the special attention of this Department.

SERVICES RENDERED

The services rendered are varied and comprehensive. No small owner need have a rubber problem today concerning which he cannot obtain free advice from the Smallholdings Department or his local Rubber Instructor, in addition to the many practical benefits he receives in the way of planting material, lining and grants for soil conservation, mesh for strainers, guaranteed acid &c. The 31 Rubber Instructors are stationed in 31 specified ranges which cover all the main rubber districts and each is responsible for the smallholdings in his area. Seven or eight Rubber Instructors are supervised by a District Field Officer, and the divisions of 2 District Field Officers by an Assistant Propaganda Officer.

Systematic visits are paid to holdings by Instructors where talks and demonstrations are given to individuals or groups of smallholders. Practical demonstrations are conducted in sheet-making, tapping, budding, disease-treatment, compost-making, &c. Holdings are lined for contour drains with the road-tracer free of charge, and on new-planting permit-areas grants are paid after the drains are completed. Rs. 14,424, Rs. 5,191 and Rs. 7,942 were paid as grants to 202, 75 and 151 peasant-class permit-holders during 1949, 1950 and 1951 respectively. The work done on each holding is carefully measured, checked and certified by the field staff before a grant is paid.

Frequent visits are paid by Instructors and all stages of work supervised whenever a smallholder is new-planting or replanting his land. Lists of all permits issued by the Rubber Controller are received by the Smallholdings Propaganda Officer and forwarded to the officer of the range concerned, who visits them within two weeks and does all that is necessary to ensure a satisfactory plantation.

General advice and supervision in maintaining, and where necessary replanting, Government Rubber Allotments given to colonists is undertaken. During 1951 all operations in replanting 87 acres of the Urumiwela Allotments

were supervised and approved planting material in the form of clonal seedlings was supplied. All allotments were planted on up-to-date lines with proper soil conservation measures &c., and are making satisfactory growth.

SHEET IMPROVEMENT

Considerable attention is paid to the improvement of smallholders' sheet so that it may fetch the best possible price. Inexpensive wattle-and-daub smokehouses of varying sizes which produce excellent sheet have been designed to suit all classes of small owners. Two demonstration houses are put up in each range annually at Departmental expense and small owners encouraged to build similar ones. Over 250 demonstration and 500 private smokehouses have been built to date under the Department's supervision.

The improvement of sheet by co-operative methods, where several small owners form themselves into a Rubber Co-operative Society and bring their latex to one centre to be converted by a trained rubber maker into grade I sheet, has been given considerable attention. The Hataraliyadda Rubber Co-operative Society, initiated by this department, has proved a great success and other similar societies have been formed by this department at Dapiligoda, Kahagalla, Aruppola, Dediyagala and Maliduwa. The main difficulty in forming more such societies is the trouble that smallholders experience in obtaining an initial loan of Rs. 2,000 to Rs. 3,000 for putting up the necessary smokehouse and coagulating shed and buying a pair of rollers.

Mesh for strainers and reliable acid bottled by the smallholdings department in sealed bottles are sold by Rubber Instructors and delivered to smallholders at concession rates. Quality Certificates and free pans are issued to those who make good sheet.

LATEX CENTRES

The Department has been responsible for organizing a scheme whereby small owners in the Kalutara District could supply their latex to the central buying organization at Katukurunda at rates considerably more advantageous than what they get by making sheet. Latex is brought by each member to a given centre and there " weighed ", bulked, ammoniated and handed to the lorry which calls daily. The organization pays 2 cents below the day's top market price of sheet for every pound of dry rubber supplied as latex and also supplies the collecting tanks, &c. Eleven centres are each supplying 20–100 gallons of latex per day at present with considerable benefit to their members. The Centres have applied to the Co-operative Department for registration as Latex Co-operative Societies.

At the commencement of the scheme and before the Latex Corporation was in a position to receive supplies there was some diffidence on the part of the Smallholders in embarking on the project. However, the Rubber

Research Institute itself arranged with the Dapiligoda Smallholders to purchase their latex daily at Ceylon Latex Corporation rates and use it in the Institute's factory at Dartonfield. The trial which extended over several months proved eminently satisfactory and the smallholders in general were convinced of the soundness of the scheme and willingly contracted with the Corporation.

A similar project to cater for areas which cannot at present be served by the Latex Corporation is now under consideration. This involves the establishment of latex centres in unserviced districts and arranging for contracts between smallholders' co-operatives and commercial estate factories for the purchase of the latex of the former by the latter for manufacture into pale crepe. It is considered that such a project using existing facilities is preferable to embarking on an expensive scheme of constructing new factories and providing staff for the purpose. Such a project, as the former, however, could after establishment be developed in certain areas where sufficient latex may be available into a smallholders' co-operative crepe factory project.

NEW PLANTING

On taking over the New Rubber Planting Scheme in 1948 it was found that no record existed of the actual condition of the large number of holdings planted under the scheme since 1939. A holding-to-holding survey was, therefore, undertaken in 1949 and an up-to-date record obtained. A total of 20,845 permit-areas were visited by Instructors and returns filled in, in respect of 18,654. Holdings were classified into 3 groups according to their growth. Out of 25,853 acres of middle-class permit areas, 34% fell into "class 1" (i.e. satisfactory growth), another 34% into "class 2" (i.e. growth poor but capable of improvement) and 25% into "class 3" (i.e. very poor growth not likely to make satisfactory plantations). Similarly out of 12,424 acres of peasant-class permit-areas, 34% fell into class 1, 30% into class 2 and 29% into class 3; and out of 698 acres of colony areas, 16% fell into class 1, 26% into class 2 and 51% into class 3. 58% of middle-class, 54% of peasant-class and 54% of colony holdings were found planted with budded rubber, the remainder consisting mainly of ordinary rubber and to a small extent of clonal seedlings.

The survey which took one year to complete also gave much useful information regarding soils, gradients of lands, tapping conditions, soil conservation, &c., on these holdings and has furnished a record of each holding whose future progress will be noted by the staff at each subsequent visit.

The demand for new-planting permits continued during 1951, and 4,213 middle and peasant-class permits covering 6,526 acres were issued by the Rubber Controller on the recommendation of the Smallholdings Department of this Institute. Each land is inspected by a Rubber Instructor before a permit is given. 5,087 inspection reports were sent to the Rubber Controller in 1951.

A close watch is kept on new-planted holdings which are nearing tapping age and Instructors continually visit them and mark tappable trees and direct operations on correct lines. This is important owing to the tendency among smallholders to tap daily, which often results in a high percentage of brown-bast disease on new budded plantations.

PLANTING MATERIAL

The Smallholdings Department supplies large quantities of approved high-yielding planting material to small owners annually. Clonal seedlings, which are hardier and easier to manage, are supplied to such limited extent as they are available, besides fairly large quantities of budded stumps of proved clones like PB. 86. Plants are supplied free to peasants and at a nominal charge to middle-class permit-holders and replanters. In 1951, 48,823 clonal seedlings were issued free and 28,745 sold. 6,925 budded stumps and 280 yards of budwood were also sold. The germination of the clonal seed crop in 1951 was a failure and only 12,000 plants were obtained from 107,000 seed, for 1952 issue. A large nursery of 78,000 ordinary rubber plants was, therefore, laid for budding and issue as budded stumps in October-December 1952. All nurseries are planted and maintained under the supervision of the Department.

REPLANTING

The extent of replanting done by smallholders in Ceylon is quite inadequate and almost negligible in comparison with that done in other Rubber producing countries like Malaya. This is mainly due to the lack of capital. The attention of the authorities has been drawn to the need for providing some financial aid to encourage replanting and it is learnt that Government is considering a " Replanting Subsidy Scheme ". A large proportion of smallholdings which were slaughter-tapped during the war years are now uneconomic and need immediate replanting with high yielding material if Ceylon's place in the rubber world is to be maintained.

Replanting work under the supervision of Rubber Instructors was completed on 103 holdings in 1951 comprising 126 acres. Replanting permits issued by the Rubber Controller in 1951, were 96 (covering 160 acres) to holdings of under 10 acres and 227 (6,024 acres) to estates of over 10 acres.

LINING FOR SOIL CONSERVATION

Instructors lined 1,661 acres on 1,350 N. R. P. S. holdings, 131 acres on 109 replanting holdings and 76 acres on 40 mature holdings for contour drains and stone terraces against soil erosion during 1951.

OTHER WORK

Propaganda in improving smallholdings is also carried out by means of leaflets, issued both in Sinhalese and English, on useful rubber subjects, advisory correspondence, competitions, lectures, participation in Agricultural shows, &c.

The following leaflets have been issued :—

(1) Budding and After-Treatment.
(2) Replanting.
(3) Sheet Making and Smoking.
(4) Tapping of Young Budded Rubber.
(5) Rubber production on Smallholdings (handbill).
(6) Scheme for supply of Smallholders' latex to the Latex Corporation, Katukurunda (handbill).

All field staff are given a special course of instruction in Rubber work on first appointment. This consists of a series of lectures as well as practical work in budding, tapping, road-tracing, &c., at the Experimental Station. Nivitigalakele.

STAFF AND LOCATION

The Staff of the Smallholdings Department is distributed as follows :—

OFFICE—

Smallholdings Propaganda Officer—Mr. W. I. Pieris, B. A. (Hort.), Smallholdings Department, Eastern Bank Building, P. O. Box 901, Colombo.

Assistant Propaganda Officer—Mr. N. W. Palihawadane, Smallholdings Department, Eastern Bank Building, P. O. Box 901, Colombo.

Clerical Staff—4 Clerks.

SOUTHERN DIVISION—

Assistant Propaganda Officer—Mr. K. Wilson de Silva, 97, De Alwis Place, Kalutara.

Probationary Assistant Propaganda Officer—Mr. P. W. W. de Silva, 97, De Alwis Place, Kalutara.

District Field Officers—(1) Mr. P. S. G. Cooray, Kuda Uduwa, Horana ; (2) Mr. D. R. Ranwala, Baddegama.

Rubber Instructors at Akuressa, Kamburupitiya, Hiniduma, Talpe, Talgaswela, Pitigala, Meegahatenna, Agalawatta, Matugama, Horana, Padukka, Kesbewa, Talangama, Dompe and Gampaha.

NORTHERN DIVISION—

Assistant Propaganda Officer—Mr. H. H. Peiris, Dehigahapitiya, Getahetta.

District Field Officers—(1) Mr. D. E. A. Abeywickrema, Buluruppe, Hettimulla, Kegalla; (2) Mr. B. D. Pedrick, Gilimale Road, Ratnapura.

Rubber Instructors at Pasyala, Nelundeniya, Warakapola, Undugoda, Kegalla, Mawanella, Galagedera, Nivitigala, Pelmadulla, Kuruwita, Eheliyagoda, Dehiowita, Kosgama, Ruanwella and Ingiriya.

The Planting and Advisory Division of the Coconut Research Institute of Ceylon

Review of operations since its formation

BY

O. B. M. CHEYNE

PLANTING SECTION

THE need for Re-planting of Coconuts in Ceylon cannot be disputed. The total extent under coconuts is roughly 1,050,000 acres and an appreciable proportion of the palms therein have reached or are reaching the stage of senility and non-production. It has been estimated that if the economic life of a coconut palm is calculated to be 70 years, the area which would become due for re-planting each year would be 1/70 of the total extent or about 15,000 acres.

In order to carry out a scheme for the replanting of coconuts in this country the Coconut Research Institute formed a special Division to undertake the work of establishing nurseries and providing planting material for this purpose. Thus the "Replanting" Division came into being in October, 1948, when a Clerk was appointed. In January, 1949, Mr. O. B. M. Cheyne was appointed to the post of "Replanting Officer" and in April of the same year Mr. P. D. Laurence Fernando was appointed Assistant Replanting Officer.

It will be noted that when it was first formed, this Division was called the "Replanting" Division but it was felt that this was a misnomer as its work was not confined solely to re-planting but also to the planting up of *new* areas, the name was therefore changed and when advisory work was also included in its activities it received its present designation of "Planting and Advisory Division". It is financed by a special vote from the Department of Agriculture (and administered by the Coconut Research Board).

The Annual Votes from the Department of Agriculture are given below :—

	Rs.
1948/49 (January/ September)	137,468
1949/50 (October/September)	179,300
1950/51 (October/September)	410,000
1951/52 (October/September)	520,500

Since its formation in 1948 this Division has greatly expanded and the present staff (exclusive of office personnel) consists of —

1 Planting Officer,
1 Assistant Planting Officer,
8 Field Assistants,
12 Nursery Attendants,

besides the 7 Advisory Field Officers.

The work of the Planting Section of this Division is chiefly concerned with the supply of planting material—i.e., coconut seedlings and seed-nuts to coconut growers all over the Island and the establishment of nurseries for this purpose in the principal coconut growing districts. A good deal of advisory work is also carried out by correspondence and by visits. This advisory work covers a very wide scope and embraces many aspects of coconut growing, including methods of cultivation, fertilizers, application of manure and pests and diseases. Any problems which require technical advice are referred to the scientific staff of the Coconut Research Institute.

The supply of first class planting material is of paramount importance and the first step to be taken towards this end by the Field Assistants is the selection of seed-nuts from carefully chosen high yielding estates.

The best quality nuts come from " Mother Palms " which should have a consistent yield record of 80 nuts per palm per annum. Such palms are however few and far between and would only supply a very small fraction of the quantity required. For this reason the practice of using " Block-nuts " has been followed ; these are the very best nuts derived from fields or blocks on estates showing sustained records of a high annual yield of nuts per palm and a good copra outturn over a period of 5 years or more.

It is difficult to find many estates that come up to this standard.

Planting material, chiefly seedlings, is supplied to private individuals, estates, and colonization schemes (the last through Government Agents, Assistant Government Agents, Divisional Revenue Officers, Rural Development Officers and Agricultural Officers).

Seed-nuts are also supplied to Agricultural Officers for nurseries laid down by them in their areas. In 1949 seed-nuts to the number of 140,000 were supplied for a nursery on the Government Farm at Bibile, while 50,000 were supplied in 1950 for the nursery at Paragahakelle for planting up 400 acres of coconuts at Wawinna in the Gal Oya Valley.

Many thousands of seedlings have been supplied to rubber estates where old rubber is being cut out and replaced with coconuts.

Nurseries

Since its inception the Planting Section of this Division has laid down up to date 14 nurseries in many parts of the Island. Difficulty was experienced at first in getting suitable land for this purpose but, thanks to

some estate owners, the Department of Agriculture and to Government Agents, land was made available on estates, Government farms, and Crown lands, and fine nurseries are now established in the following places :—

Coconut Research Institute Nurseries

	Nursery	*Situation*	*Capacity*	
1948/49	Ratmalagara	Madampe	22,975	
	Carmel	Kurunegala	25,000	
				47,975 nuts
1949/50	Ratmalagara	Madampe	77,204	
	Carmel	Kurunegala	32,200	
	St. Anne's	Puttalam	40,000	
	Labuduwa	Galle	35,000	
	Walpita	Kotadeniyawa	41,900	
	Hettipola	Hettipola	13,750	
				204,054 nuts
1950/51	Ratmalagara	Madampe	109,356	
	Carmel	Kurunegala	31,704	
	St. Anne's	Puttalam	67,298	
	Labuduwa	Galle	30,251	
	Walpita	Kotadeniyawa	47,837	
	Hettipola	Hettipola	32,800	
	Palugaswewa	Rajakadaluwa	30,000	
	Pappamodai	Mannar	10,000	
	Tharakundu	Mannar	15,000	
	Bandirippuwa	Lunuwila	6,400	
				380,646 nuts
1951/52	Bandirippuwa	Lunuwila	6,400	
	Ratmalagara	Madampe	130,000	
	Carmel old	Kurunegala	30,000	
	Carmel new	Kurunegala	30,000	
	St. Anne's	Puttalam	75,000	
	Labuduwa	Galle	35,000	
	Walpita	Kotadeniyawa	40,000	
	Hettipola	Hettipola	45,000	
	Palugaswewa	Rajakadaluwa	40,000	
	Pappamodai	Mannar	10,000	
	Tharakundu	Mannar	15,000	
	Kalawewa	Kalawewa	75,000	
	Bedigama	Tangalla	75,000	
	Killinochchi	Killinochchi	10,000	
				616,400 nuts

Two more nurseries are shortly to be established, one very large one at Wilpotha (Crown land near Battuluoya) to accommodate 100,000 seed-nuts and another at Arampola Government Estate, to accommodate 30,000 seed-nuts.

ADVISORY SECTION

The work of the Advisory Officers is mainly concerned with giving advice to coconut growers, more particularly to members of Coconut Producers' Co-operative Societies, on modern scientific methods of agriculture based on the latest results of experiments and investigations of the Coconut

Research Institute. They are responsible for the establishment of nurseries for such societies and for the selection and distribution of seedlings therefrom. It is also part of their duties to see that the seedlings issued to members are correctly planted and that the young plants receive proper attention.

Each Advisory Field Officer is given a " range " of operations, selected by the Administration. At present these have been allocated as follows :—

(1) Kurunegala District with headquarters at Kurunegala.
(2) Chilaw/Puttalam with headquarters at Madampe.
(3) Negombo/Gampaha with headquarters at Walpita Farm, Kotadeniyawa.
(4 Southern Province with headqurters at Matara.
(5) Northern Province* with headquarters at Pallai (Jaffna area).
(6) Batticaloa District* with headquarters still to be determined.

Advisory visits are at present confined to coconut properties of not more than 50 acres in extent and a report on each property visited has to be submitted to headquarters by the visiting officer.

They draw up and submit lists of Coconut Producers' Co-operative Societies, Rural Development Societies, Village Committees and other bodies connected with the coconut industry in each of their ranges, and in order to meet members and obtain a better working knowledge of them and their needs, they visit all such societies and periodically pay advisory visits to their holdings. They are also expected to attend meetings of Co-operative and Rural Development Societies as often as possible.

One of the most important of their duties is what is known as a " Follow-up " service, i.e., they visit and report on the condition of plants supplied to smallholdings. In many cases it has been found that, after the seedlings have been paid for by members and planted little or no attention has been paid to the after-care of the plants, a high percentage of which have died through neglect or have been destroyed by cattle due to inadequate protective measures in the shape of fencing. It is in such cases that the Advisory Officers point out mistakes and how to remedy them and give due warning of the consequences of apathy and negligence.

They have also to do a good deal of propaganda work among smallholders and to see that Coconut Research Institute literature in the shape of free leaflets on all aspects of coconut planting, pests and diseases and cultivation are distributed throughout villages in coconut growing areas. In this they seek the assistance and co-operation of village headmen, Rural Development Officers and Divisional Revenue Officers. They are expected too to organise visits by smallholders in their ranges to demonstration plots and

* At present there is no officer stationed in either the Jaffna or Batticaloa ranges but these posts will be filled very shortly. Two Officers will also be stationed at the Coconut Research Institute Headquartres as Relieving Officers.

experiment stations of the Institute and also to take a prominent part in any rural agricultural exhibitions, where they are often asked to give talks on matters in connection with coconut planting methods, upkeep, cultivation and manuring as well as to make known the functions of the Coconut Research Institute and of the Planting and Advisory Division in particular.

In addition to the ordinary work of this Division a Land Utilization Survey is now being carried out in the Kalpitiya area by a team consisting of 2 Advisory Field Officers and 4 Field Attendants. Up-to-date, reports on 226 separate holdings have been sent in to Headquarters by these two Advisory Field Officers.

Assistance to Coconut Producers' Co-operative Societies

As stated earlier in this review, the establishment of nurseries for Coconut Producers' Co-operative Societies is undertaken by the Planting and Advisory Division of this Institute which supplies these societies with selected seed-nuts (free of cost), barbed wire and fence posts. These fencing materials remain the property of the Coconut Research Institute. Construction of the beds, laying down of seed-nuts and erection of wire fencing is also done at the expense of the Institute, thereafter the up-keep of the nursery is the responsibility of the Society concerned. When the seedlings are ready for distribution our Advisory Field Officers see to the selection of good and rejection of bad plants and the good ones are then handed over to the society which pays for them at the rate of 25 cents each (*Present* price). The rejections are destroyed. So far this scheme for assistance has been working satisfactorily, but there have been one or two cases where societies have been unable to dispose of quite an appreciable number of their seedlings. This is due chiefly to the society's failure to obtain more accurate information as to their requirements before placing their orders for seed-nuts.

Originally expenditure in connection with the establishment of nurseries for Co-operative Societies was met by the provision of a special vote from the Commissioner of Commodity Purchase but during the latter part of 1949 this vote was exhausted and not renewed ; since then expenditure on this account has been met by the Planting and Advisory Division from the funds allocated to it by the Department of Agriculture and administered by the Coconut Research Institute.

There is no doubt that the Coconut Rehabilitation Project, especially where smallholdings are concerned, can be appreciably assisted and accelerated through the medium of Coconut Producers' Co-operative Societies whose members (most of whom are small-holders) can obtain their planting requirements from the nurseries of the societies to which they belong. The demand for seedlings from members of Co-operative Societies is increasing and while some existing nurseries may have to be enlarged new ones will have to be established for other Coconut Producers' Co-operative Societies.

From a total of 5 nurseries accommodating 61,000 seed-nuts in 1948-49 the number of nurseries established by this Institute for Co-operative Societies has increased to 13 with a capacity of 217,000 seed-nuts. The following statement showing the nurseries established by us for such societies since October 1, 1948* with the number of seed-nuts laid down will prove of interest :—

1948/49		*1949/50*		*1950/51*		*1951/52*	
Bolgoda	1,000	Bolgoda	1,000	Bolgoda	2,000	Bolgoda	2,000
Sandalankawa	20,000	Batticaloa	24,000	Batticaloa	15,000	Batticaloa	15,000
Dunagaha	10,000	Gokarella	5,000	Gokarella	5,000	Gokarella	5,000
Mutugala	20,000	Madampella	25,000	Madampella	25,000	Madampella	25,000
Veyangoda	10,000	Kurunegala	17,000	Madampe	15,000	Madampe	20,000
		Sandalankawa	20,000	Mundel	15,000	Mundel	20,000
		Mutugala	20,000	Nattandiya	20,000	Nattandiya	20,000
		Veyangoda	10,000	Puttalam	20,000	Puttalam	20,000
		Dunagaha	10,000	Kurunegala	16,196	Kurunegala	15,000
				Veyangoda	7,000	Veyangoda	10,000
				Dunagaha	25,000	Dunagaha	25,000
				Mutugala	20,000	Mutugala	20,000
				Sandalankawa	18,000	Sandalankawa	20,000
Total Nurseries 5	61,000	9 –	127,000	13–	203,196	13 –	217,000

The average quantity of good selected seedlings obtained from seed-nuts laid down is about 60 per cent.

It is not possible to state with any exactitude the acreage that has been re-planted and newly planted since the Planting and Advisory Division started active operations in March, 1949, as much of the planting material supplied has been used for the filling of vacancies (supplying); all that can be said is that seed-nuts and seedlings have been distributed to various sources sufficient to plant up approximately 20,000 acres.

* Financial year—October 1 to September 30.

Carnivorous Plants of Ceylon

BY

J. E. SENARATNA

PARADOXICAL as it may seem, there are plants which entrap and kill and feed on insects and other small animals. Such plants are referred to as carnivorous or insectivorous plants, the former term being better as it more accurately describes the attribute. From different parts of the world, over four hundred and fifty species adapted in various ways to this purpose have been described, and a brief account is given here with special reference to the Ceylon species.

Although from very early times insects had been observed to be caught and killed on the sticky leaves of certain plants, Darwin was the first to show that plants had evolved these contrivances so as to entrap and kill insects in order to obtain a supply of organic substances containing nitrogen compounds which were difficult to obtain in sufficient quantity from the habitats in which the plants were growing. Darwin aroused interest and other investigators followed.

The earlier workers, including Darwin, aimed at explaining natural phenomena so as to make them appear simple. Later investigators, working with better technique, with more precise and accurate means of observation have shown that these phenomena are much more complex. Even today they are not completely understood but we appear to be much nearer the truth.

PITCHER PLANTS : *Nepenthes distillatoria* L. (*Bandura vel.* Sinhalese) is the only species of pitcher plant occurring naturally in Ceylon. It is a shrubby, climbing plant, existing generally in patches of several plants growing closely together in a matted mass. From the stem arises the leaf stalk which broadens out into a leaf-like form and then continues as a cylindrical, stout, twine-like, prehensile spiral which dips down in a stiff, cylindrical form carrying at its end an upturned open pitcher with an over-hanging open lid.

The flattened basal portion of the leaf stalk functions as a leaf, the spiral middle region is prehensile and winds around some nearby support thus enabling the plant to climb and also suspending the pitcher so as to make it stand out in an upright position. The development of the pitcher is rather interesting. At first it is the slightly broadened end of the leaf and this begins to increase in size at a rapid rate. Soon it assumes a pitcher form with fluid inside at the base and closed over by a lid. When the pitcher is fully developed the lid opens wide leaving a free passage into the pitcher. The pitcher is of two forms according to its position on the plant.

In the smaller plants the basal leaves produce a smaller and relatively broader type of pitcher bearing two flat wings on the side away from the stalk. These pitchers are often seen resting on the ground and, perhaps, the wings are developed in order to aid ants and other creeping insects to crawl along them into the pitcher. It may be mentioned that these wings are also deeply coloured with a reddish brown pigment, thus serving as an additional attraction and for greater conspicuity.

On the older climbing stems is produced another type of pitcher which is suspended, often four to five feet away from the ground, on a larger and stouter petiole. The pitcher is relatively more elongated and green in colour and the lateral wings are not developed. The lid is coloured a reddish brown and acts as a standard for attracting insects. The lower third of the pitcher contains a digestive fluid secreted by the glands in that region, above which the wall is very smooth and slippery up to the open mouth which is supported and kept in position by a stiff convex ridge fluted transversely. At the inner edge of this rim, honey is secreted. Ants and other insects in search of the honey creep along the ridge and then down to the inner edge of the rim but in trying to reach the honey most of them losing their foothold drop into the fluid below, where they decompose and are gradually absorbed by the plant.

The effectiveness of this contrivance is not fully appreciated until one has actually examined several pitchers. An examination of the contents of fifty pitchers in their natural habitat showed that on the average each had about fifty of the local large bronze-coloured ants and a few other miscellaneous insects, chiefly crawling ones, while one contained as many as a hundred and twenty of the large ants. In several pitchers were observed in addition to decaying insects, little segmented worm-like insect larvae living in the fluid, perhaps much as intestinal worms do in man and other animals.

In Ceylon, the pitcher plant occurs in wet places, especially on swamps, by water-courses in the moist low country and up to an elevation of two thousand feet above sea level. The Ceylon pitcher plant, *Nepenthes distillatoria* L., described above, is endemic, that is, it occurs naturally only in Ceylon. It may be of interest to mention that Grimm, a Swedish physician, who was in Ceylon in 1674 published a detailed description of it together with a figure in 1682. That the local inhabitants have been familiar with the nature of the pitcher may be seen from one curious use they find for it. Villagers gather the stems with pitchers and leave them on kitchen lofts to rid them of cockrocahes and similar insects. The stems are used as rough cordage.

SUNDEWS : Of the sundews, three species occur in Ceylon. *Drosera burmanni* Vahl (*Vata essa*, Sinhalese) is a stemless plant with the leaves forming a rosette on the ground and it occurs in wet places at all elevations. *Drosera indica L.* (*Kandulessa*, Sinhalese) has a straggling stem and narrow leaves. Its flowers are blue or mauve while those of the other two are white, and it is confined to the low country. *Drosera peltata* Sm. has a short, erect stem arising from a bulbil and bears numerous half-moon shaped leaves. It occurs only in the upper montane zone.

The mode of action in all three species is the same and that of the commonest, *Drosera burmanni* (*Vata essa*) is described below. The plant usually has four to eight leaves. On the upper surface of the leaf are numerous short finger-like papillae, the tentacles, bearing at the end a rounded knob secreting a viscid sticky slime. The tentacles are arranged in rough circles from the centre to the margin of the leaf. Attracted by the glistening drops, when an ant (or flying insect) gets on a leaf, the sticky fluid of the tentacles holds it fast. When the ant tries to cut itself away, its mouth parts also get held fast in the viscid threads of the fluid, and the more it struggles the more it gets entangled. Soon other tentacles bend over and stick on the ant and in about three hours the ant ceases to struggle. The glandular ends of the tentacles secrete a digestive fluid which in a few days digests the soft parts leaving only the hard outer coat. The tentacles spread out and the trap is set for the next victim.

BLADDERWORTS : There are twelve species of bladderworts (*Utricularia* spp.) in Ceylon, three growing in water and nine in wet situations. In the latter the bladders are not always easy to observe on account of their fugacious character. It is in the three species growing with their stems submerged in water that the bladders are most clearly observed. They are found in the water of rice fields, tanks, ditches, drains, ponds, rivers, streams and other water courses. Of the three species, *Utricularia exoleta* R. Br. has thread-like stems and very small leaves with minute bladders. It occurs at low and mid country elevations. *Utricularia stellaris* L. f. has large submerged leaves and small globular ovoid bladders. It is the only species with a whorl of spongy floats on the stalk below the cluster of flowers. It occurs in the low country in the dry region. *Utricularia flexuosa* Vahl has large leaves and almost globose bladders. It is found in the low country in both the dry and the moist region. All three species have yellow flowers.

The mechanism of the trap is practically the same in all and that of the commonest, *Utricularia flexuosa*, is described below. The bladder is submerged and attached to the stem by a short stalk. The mouth of the bladder is small and circular and is closed by a circular valve opening inwards and resting in a groove lined with mucilage-secreting cells and making a water tight closure with a firm transparent membrane. On the inner wall of the bladder are specialised cells for absorbing water and dissolved decaying animal matter. Specialised cells pump out water so that a negative pressure obtains within, and the bladders appear concave on the sides. On the external surface of the valve are some sensitive hairs pointing outwards into the water. When an object touches these hairs, the valve is stimulated, it rises upwards from the groove, and on account of the negative pressure within, water is sucked in together with any insects and other objects floating or swimming in it. All this happens in a moment, the sides of the bladder become convex, and the valve is back in position. At the mouth of the bladder are stiff branched hairs which lead the prey towards the entrance to the trap. Whether the animals caught in the trap are digested by enzymes secreted by the plant or whether they are digested by bacteria and merely absorbed by the plant is still somewhat of an open question.

FIG. 1.—Pitcher plant, *Nepenthes distillatoria* L.

A. Upper part of stem with inflorescence x $\frac{1}{4}$.
B. Leaf with open pitcher x $\frac{1}{4}$.
C. Longitudinal section of pitcher x '.
D. Fruits x $\frac{1}{4}$.

FIG. 2.—Sundews.

A. *Drosera indica* L. x $\frac{1}{2}$.
B. *Drosera burmanni* Vahl. x $\frac{1}{2}$.
C. *Drosera peltata* Sm. x$\frac{1}{2}$, and leaf showing tentacles x '.
Bladderwort, D. *Utricularia flexuosa* Vahl. x $\frac{1}{2}$.

The diversity and perfection of these contrivances seem to indicate the importance of the carnivorous habit to the plants. The general restriction of the plants to water or marsh and similar habitats appears to confirm this view. On the other hand, the vast majority of plants in such habitats show no such unusual mode of nutrition, and yet appear to thrive as well as the carnivorous plants. It may, however, be justifiable to assume that plants do benefit from this accessory mode of nutrition, and that these contrivances have been evolved in response to an environment lacking in necessary or at least highly desirable compounds available in this manner but otherwise unobtainable from their habitat.

Paddy Straw as a Feed for Cattle

BY

D. G. PANDITTESEKERE

IN rice growing countries the grain is the staple food of the human population and the straw that of the cattle. Paddy being practically the only crop in these areas the utilization of both the grain and straw to the maximum possible extent is necessary for sound economy.

Cereal straws due to their nutritional poverty become particularly important only in times of war when feedingstuffs for animals become scarce. These straws in general are composed mainly of crude fibre and Nitrogen-Free-Extract, the two together forming the total carbohydrates. It is however unfortunate that these two constituents of straw are low in digestibility. The amounts of protein and fat digested are so small as to be negligible. The ash contains about 30 per cent. of silica and traces of calcium and phosphorus.

If therefore cereal straws are to be made useful the digestibility of the carbohydrate fraction should be considerably increased. In this fraction crude fibre constitutes more than half the soluble carbohydrates. Crude fibre itself is composed of complex polysaccharides, the most important being lignin and cutin which form a protective covering over the cellulose (1). This covering prevents the digestive juices or the rumen bacteria from breaking down the cellulose material. Cellulose however is largely digested by the bacteria in the rumen of cattle or caecum of horses.

Cereals like other grasses on maturity undergo lignification, and with age the lignin cellulose fraction increases. Further in the selection of cereals that do not lodge, varieties with high lignocellulose contents are selected and consequently straw from the improved strains of cereals will contain more of the lignocellulose fraction. If, however, a crop is cut in the early stages as in the case of oats, the crude fibre and lignin are low. Lignin contains in its molecule methoxy and acetyl groups which are easily split up by the action of heat and alkali. This treatment can completely remove the lignin from the straw.

The pioneer workers in this field subjected chopped or powdered straw to hot alkali under high pressure. It was however found by Beckman (2) that neither heat nor pressure was necessary to obtain an increase in the digestibility of lye treated straw. He adopted the simple method of steeping

chopped straw in 1·25 per cent. caustic soda solution in the cold and washed out the soda from the treated material. This method has the advantage of being as effective but much less expensive than the older ones. It is claimed that the starch equivalent of the straw is increased 50 per cent.

In the case of paddy straw however there is a further difficulty in its efficient utilization. The animal nutrition workers in India (3) were faced with the problem why cattle in the rice-growing tracts were unthrifty and in poor condition while those in the corresponding wheat-growing areas were vigorous and productive. This was all the more puzzling as the nutritive value of the two straws which constituted 80 per cent. of the roughage ration of cattle was almost identical. The digestible crude protein is 0·0 and the starch equivalent is 22 in both cases.

Indian animal nutrition workers (4) found that rice straw contained large quantities of oxalates, the major portion of which was in combination with potassium, while a small but appreciable amount was in the form of calcium oxalate insoluble in the gastric juices. This small quantity of calcium oxalate could not account for the negative balance. The potassium oxalate on the other hand was converted into potassium carbonate and bicarbonate in the fore stomach of the cattle and interfered with the assimilation of calcium. These decomposed products cause severe alkali symptoms or alkalosis which either inhibits the flow of gastric juice or neutralises its effective acidity as a result of which the solubility of calcium in the feeds preparatory to its absorption is adversely affected. The calcium passes out in the faeces unabsorbed leaving the animals in a deficit calcium balance.

Lye treatment of straw, i.e., steeping the straw in a 1·25 per cent. solution of caustic soda for 24 hours and washing it removes about 90 per cent. of the oxalates. The protein still remains totally indigestible but the carbohydrate fraction is increased in quantity and digestibility with a consequent increase in the total digestible nutrients. The adoption of lye treatment is however not feasible under normal village conditions. Steeping the straw in water for 24 hours was next tried and the Indian workers claim that the same beneficial effects as lye treatment are obtained but to a slightly less degree.

Ceylon with one million acres of paddy land produces about one million tons of straw annually, which is the largest source of feedingstuffs for cattle in the island. As nearly 80 per cent. of the cattle population is in a state of undernourishment the efficient utilization of the paddy straw assumes a problem of major importance. Investigations were accordingly made to determine the effects of water washing and lye treatment on the chemical composition and on the digestibility of the paddy straw.

THE EFFECT OF WATER WASHING AND LYE TREATMENT ON THE COMPOSITION OF STRAW

The first stage of this investigation deals with the effect of water washing and lye treatment on the chemical composition of some Ceylon paddy straws. For this purpose representative samples of straw were obtained from different paddy tracts of the Island.

The water washed straw was prepared by steeping the straw cut up into lengths of about 4 inches, in water for 24 hours. At the end of the steeping the material was washed with two changes of water and dried.

For lye treatment, the straw was cut to the same length and steeped in a solution of 1·25 per cent. caustic soda for 24 hours, the material was then washed free of caustic soda and dried.

Analyses of the different straws untreated, water-washed and lye treated were carried out. The results are given in Table 1. Averages of the ten samples of straw untreated, water-washed and lye treated are shown at the bottom of the table.

If the averages are considered the following trend in the change in composition of the straws may be noted :

(*a*) With water-washing the ash, protein, fat, carbohydrates, potash and oxalates are significantly decreased. The percentage losses calculated on the averages are : —12·5, 11·6, 14·4, 1·9, 62·9, and 49·6, respectively. On the other hand the fibre, lime and phosphates have increased by 11·19, 34·88, and 162·50 respectively,

(*b*) With lye-washing the ash, protein, carbohydrates, phosphates, potash and oxalates have suffered further decrease. The percentage loss of these constituents being 53·61, 23·68, 1·49, 10·84, 91·18, and 88·80 respectively. The fibre and lime have however increased by 45·96 and 58·12 respectively.

It is clear that both these treatments remove potassium oxalate in which form the major portion of the oxalates are present in the straw. Both treatments should accordingly enhance the feeding value of straw.

Examination of the individual percentage losses of potash and oxalate give a clearer picture. Table II gives the individual percentages of these two constituents under the different treatments and the corresponding losses. From this it will be seen that the quantity of both the potash and oxalates removed by lye treatment is high and more or less constant, while water washing removes less of these constituent and the lossess are more eratic. Lye treatment is evidently more effective.

TABLE I

Percentage Composition of Treated and Untreated Straws

(on dry matter basis)

No.	Locality	Variety	Season	Age	Treatment	Ash	Protein	Fibre	Fat	Carbohydrates	Lime CaO	Phosphate P_2O_5	Potash K_2O	Oxalates
				Mths.		%	%	%	%	%	%	%	%	%
1	Peradeniya	Balamawi	Yala	4½	Untreated	21·68	3·60	31·84	·65	42·23	·23	·32	1·36	·66
	Do.	,,	,,	,,	Water washed	19·84	3·76	33·61	·40	42·39	·43	·67	·70	·27
	Do.	,,	,,	,,	Lye washed	8·16	3·39	48·25	·73	3 47	·48	·08	·22	·06
2	Paranthan	Pachchaperumal	Maha	3	Untreated	16·45	3·43	34·70	·47	44·15	·58	·11	2·04	1·70
	Do.	,,	,,	,,	Water washed	12·17	3·17	38·92	·35	45·39	·60	·49	·49	·79
	Do.	,,	,,	,,	Lye washed	7·07	2·84	49·19	·47	40 13	·80	·04	·18	·33
3	Do.	Vellai-Illankalayan	Yala	4	Untreated	15·78	4·57	35·62	·50	43·53	·39	·30	2·19	1·34
	Do.	,,	,,	,,	Water washed	11·99	3·83	37·71	·38	46·09	·47	·72	·49	·43
	Do.	,,	,,	,,	Lye washed	5·86	3·49	51·42	·46	38·77	·59	·07	·25	·12
4	Batalagoda	Pachchaperumal	Maha	3	Untreated	17·96	3·11	35·39	·65	42·89	·38	·12	1·21	1·28
	Do.	,,	,,	,,	Water washed	15·18	2·46	38·23	·44	43·69	·63	·68	·57	·78
	Do.	,,	,,	,,	Lye washed	8·10	2·17	51·35	·51	37·87	·76	·03	·19	·17
5	Do.	,,	,,	,,	Untreated	15·60	3·42	33·61	·78	46·59	·54	·19	1·81	1·41
	Do.	,,	,,	,,	Water washed	14·70	3·84	36·25	·62	44·59	·64	·62	·81	·94
	Do.	,,	,,	,,	Lye washed	6·77	3·03	50·04	·63	39·53	·72	·03	·17	·19
6	Do.	Podowi	,,	5	Untreated	15·98	4·34	33·18	·75	45·75	·31	·12	1·64	1·01
	Do.	,,	,,	,,	Water washed	14·58	3·42	35·65	·55	45·80	·40	·62	·62	·57
	Do.	,,	,,	,,	Lye washed	8·96	3·13	47·81	·78	39·32	·52	·04	·13	·09
7	Do.	Vellai Illankaliyan	,,	4	Untreated	18·63	4·30	32·00	·80	44·27	·46	·24	1·81	1·54
	Do.	,,	,,	,,	Water washed	16·48	4·11	34·22	·34	44·85	·75	·60	·41	·97
	Do.	,,	,,	,,	Lye washed	10·31	3·42	49·19	·73	36·35	·71	·04	·17	·12
8	Mylagastenne	Godael	—	—	Untreated	17·79	5·60	36·41	·93	39·27	·53	·39	1·28	1·06
	Do.	,,	—	—	Water washed	16·69	4·49	43·57	·90	34·35	·59	·78	·61	·46
	Do.	,,	—	—	Lye washed	9·51	3·55	50·71	·86	35·37	·71	·06	·14	·11
9	Tissamaharama	Sulai	Maha	3½	Untreated	23·72	4·62	33·05	·66	37·95	·47	·33	1·78	1·23
	Do.	,,	,,	,,	Water washed	21·12	3·70	40·93	·90	33·35	·62	·61	·79	·52
	Do.	,,	,,	,,	Lye washed	10·58	3·14	50·58	·69	35·01	·77	·04	·18	·12
10	Hanguranketa	Heeneti	Yala	4	Untreated	22·23	2·74	34·66	·50	39·81	·44	·29	1·90	1·25
	Do.	,,	,,	,,	Water washed	19·88	2·35	39·51	·80	37·46	·62	·50	·77	·52
	Do.	,,	,,	,,	Lye washed	10·90	2·12	48·47	·69	37·82	·75	·04	·20	·12
	Average				Untreated	18·58	3·97	34·05	·67	42·72	·43	·24	1·70	1·25
	Do.				Water washed	16·26	3·51	37·86	·57	41·90	·58	·63	·63	·63
	Do.				Lye washed	8·62	3·03	49·70	·66	38·09	·68	·05	·18	·14
	Loss or Gain by Water Washing					—12·49	—11·59	+11·19	—14·93	— 1·92	+34·88	+162.50	—62·94	—49·60
	Loss or Gain in Lye Treatment					—53·61	—23·68	+45·96	— 1·49	—10·84	+58·14	+ 79.17	—91·18	—88·80

TABLE II

Percentages of Potash and Oxalates in the Straws under the Different Treatments and Losses Effected

		% Potash			% Loss of Potash by		% Oxalates			% Loss of Oxalates by	
		Untreated	Water washed	Lye treatment	Water washed	Lye treatment	Untreated	Water washed	Lye treated	Water washed	Lye treated
1.	Peradeniya (Balamawi)	1·36	·70	·22	48·53	83·82	·66	·27	·06	59·09	90·91
2.	Paranthan (P. P.)	2·04	·49	·18	75·98	91·18	1·70	·70	·33	58·53	80·59
3.	Paranthan (V. I.)	2·19	·49	·25	77·63	88·58	1·34	·43	·12	67·91	91·04
4.	Batalagoda (P. P.)	1·21	·57	·19	52·89	84·30	1·28	·78	·17	39·06	86·72
5.	Batalagoda (P. P.)	1·81	·81	·17	55·25	90·61	1·41	·94	·19	33·33	86·52
6.	Batalagoda (Podiwi)	1·64	·62	·18	62·20	92·07	1·01	·57	·09	43·56	91·09
7.	Batalagoda (V. I.)	1·81	·41	·17	77·35	90·61	1·54	·07	·12	37·01	92·21
8.	Mylagastenne (Godael)	1·28	·61	·14	52·34	89·06	1·06	·46	·11	56·60	89·62
9.	Hanguranketa (Heeniti)	1·90	·77	·20	59·47	89·06	1·25	·52	·12	58·40	90·40
10.	Tissamaharama (Sulai)	1·78	·79	·18	55·62	89·89	1·23	·52	·12	57·72	90·24

THE EFFECT OF WATER WASHING AND LYE TREATMENT ON THE DIGESTIBILITY OF STRAW

The second stage of this investigation was the determination of the effects of water washing and lye treatment on the digestibility of the straw.

In determining the digestibility of a feedingstuff the material is fed to animals for which it is meant under strict y controlled conditions and the amounts of the various constituents digested determined. For arriving at this figure the amount of each constituent actually eaten is determined and the amount of this constituent in the faeces deducted from it. The percentage digested is called the Co-efficient of digestibility for that particular constituent. In such a trial the ration fed should be balanced as far as possible for the maintenance requirements of the animal as regards the dry matter it can eat and the rough digestible protein and total digestible nutrients. Few feedingstuffs are so balanced in themselves. Roughages like grasses, grass hays, cereal straws, &c., are low in digestible protein while the concentrates e.g., oil cakes, grains, &c., on the other hand are not sufficiently bulky. It is therefore necessary to make up a balanced ration with the feedingstuffs under test and one or more other feedingstuffs to balance it.

Paddy straw contains 3–5 per cent. crude protein but has little or no digestible protein. In computing a ration it is therefore best to leave out any contribution of protein from paddy straw and provide for the necessary protein by the addition of an oil cake or other concentrate.

In this trial assuming that there is no protein in the straw sufficient coconut poonac was used to meet this need. There were three types of straw to be tested, namely untreated straw, water washed straw and lye treated straw, and three rations were worked out. The rations consisted of the straw together with the same amount of coconut poonac to make up the protein. These are shown below :—

Ration No. 1	1¾ lb. coconut poonac	.. 6 lb. untreated straw
Ration No. 2	1¾ lb. coconut poonac	.. 6 lb. water washed straw
Ration No. 3	1¾ lb. coconut poonac	.. 6 lb. lye treated straw

Six adult Sinhala bulls of the Karagoda Uyangoda strain of similar weight 455–493 lb. between 4–4½ years old were selected. The animals which were in good health and condition, were trained to the digestibility harness as shown in plate I for collecting faeces and urine. The six bulls were grouped into three batches of two each as follows :—

Batch No. 1	Bull No. 1
	,, No. 2
Batch No. 2	Bull No. 3
	,, No. 4
Batch No. 3	Bull No. 5
	,, No. 6

To eliminate the variation in the digestibility of the individual animals every animal batch received each treatment in rotation in the three periods.

During the preliminary period of 7 days each batch of animals was fed the ration they were to be put on, to get accustomed to it, to see whether there was any ill effect and to clear the digestive tract of the remains of the food taken previously. At the end of this period the actual trial was started and the collection of the faeces and the urine was made daily for ten days. The coconut poonac together with ½ ounce of common salt was given to the animals at 9 a.m. and when they had eaten this the straw was offered to them throughout the day. Water was offered frequently. The faeces were collected from time to time off the bags of each into a weighed bin bearing the number of the animal and containing a small quantity of formalin. The urine was similarly collected into bottles. The collections of both the faeces and the urine were made throughout the day and night. The collected faeces was weighed daily at 8.30 a.m., and samples taken for analysis. The urine was measured simultaneously and aliquots drawn for analysis.

When the collection period of ten days had terminated the animals were kept on their respective rations but without the digestibility harness and weighed on three successive days.

Between each period the animals assumed their normal life for about one and a half months before they were put on to the next test. The main reason for this procedure was that the animals were deprived of any green material during the period under trial. Incidentally it may be stated that this was the first time a digestibility trial was carried out in Ceylon.

The bulls when first brought were semi-wild and unapproachable. They had to be castrated, made docile and trained to the digestibility harness. When the preliminary trial of each period was started the bulls were put into the metabolism stalls so that the faeces and urine of each animal could be collected separately without any confusion and that each animal ate only the food given it and not from its neighbour. Plate 2 shows two metabolism

stalls. In one the animal is in place and the other is empty to show the partition, the feed trough and the stanchion. The stanchion is used to confine the animals feeding to its own trough. These stanchions can be dispensed with if the animals are trained to be tied to the supports on either side of the trough. Plate 3 shows all six animals in the stalls with full harness.

The preparation of the water-washed and lye-treated straw was done in the same way as in the laboratory but on a larger scale. The straw was cut up into 4–6 inch lengths and for lye-treatment was steeped in a concrete tank which held about half a cwt. of straw at a time, with 1·25 per cent. lye (sodium hydroxide solution) for 24 hours. The lye solution was then drained out and the straw washed free of the lye. The resultant straw was dried and stored. The water washing was done in a similar tank by steeping the straw in water for 24 hours, draining the water, washing it with two changes of water and drying. For each period fresh lots of these straws were prepared.

When the three types of straw were weighed for the animals each morning a sample of each was taken the moisture determined and the balance of the sample retained in a bin. At the end of the ten days the straw in each bin was mixed and a sample drawn for analysis. The same procedure was adopted in the case of the coconut poonac. It was thus possible to ensure an accurate measure of the straw and coconut poonac eaten by the animals.

The three types of straw and the coconut poonac from each of the ten-day collections together with the faeces from the six bulls were analysed separately for all the constituents. But the urine was analysed only for nitrogen, calcium and phosphorus. From these results the amounts of different constituents consumed from the straw and poonac and the amount of the different constituents in the faeces voided were calculated. The difference is taken as the amount digested and the percentage of this difference is the digestibility co-efficient for each constituent in the whole ration. The digestibility co-efficients of the three types of straw alone were calculated by deducting the amounts digested from the coconut poonac. The digestibility co-efficients of coconut poonac were taken from Morrison (1948)—(5).

TABLE III

Food Consumption (on dry basis) per all six Animals for each Treatment per day

Straw	*Consumed*		*Total Intake*	*Weight of Bulls*	*Consumption per 100 lb. live weight*	
	from Straw	*from Coconut Poonac*				
	Gms.	*Gms.*	*Gms.*	*lb.*	*Gms.*	*lb.*
Untreated Straw ..	19,570 ..	3,956·0 ..	23,536 ..	3,068 ..	767·1 ..	1·67
Water Washed Straw	17,469 ..	3,956·0 ..	21,425 ..	3,055 ..	701·3 ..	1·55
Lye Treated Straw ..	15,558 ..	3,956·0 ..	19,514 ..	3,046 ..	640·6 ..	1·45

The food consumption on dry basis is given in table III. The results are tabled as the total consumed by the six animals in one day and the total weights of the six animals for the three different types of straw. The data shows that the animals have eaten less than their normal intake of dry matter which is 2–2·5 lb. per 100 lb. of live weight. The consumption is highest in the untreated straw and lowest in the lye treated straw. It is however, not the gross consumption that is important but the actual amount digested. In this the lye treated straw is highest as will be seen later.

TABLE IV

Percentage Composition of the Straw and Poonac (on dry basis)

	Dry matter	*Mineral matter*	*Crude protein*	*Ether extract*	*Crude fibre*	*Nitrogen free extract*	*Total Carbo-hydrates*	*Cal-cium*	*Phos-phorous*
UNTREATED STRAW									
1st Period ..	87·80	19·96	2·52	0·78	34·13	42·61	76·74	·24	·12
2nd Period ..	91·69	17·24	3·14	0·64	36·77	42·21	78·98	·23	·11
3rd Period ..	89·68	18·14	2·92	0·88	36·73	41·33	78·06	·20	·11
Average ..	89·32	18·45	2.86	0.77	35·88	42·05	77·59	·22	·11
WATER WASHED STRAW									
1st Period ..	88·08	19·63	2·40	0·83	36·44	40·70	77·14	·38	·33
2nd Period ..	89·70	14·87	2·74	0·78	40·62	40·99	81·61	·31	·30
3rd Period ..	89·94	15·76	2·22	0·97	39·06	41·99	81·05	·28	·32
Average ..	89·24	16·75	2·45	0.86	38·71	41·23	79·93	·32	·32
LYE WASHED STRAW									
1st Period ..	88·94	13·50	2·54	0·80	44·22	38·94	83·16	·50	·08
2nd Period ..	91·23	12·11	2·63	0·73	44·50	40·03	84·53	·41	·09
3rd Period ..	89·12	15·59	2·41	0·99	42·15	38·86	81·01	·38	·08
Average ..	89·76	13·73	2·53	0·84	43·62	39·28	82·90	·43	·08
COCONUT POONAC									
1st Period ..	87·70	5·59	21·20	14·45	16·52	42·24	58·76	·06	·52
2nd Period ..	88·48	5·66	21·51	14·63	16·29	41·91	58·20	·07	·52
3rd Period ..	89·42	5·76	20·93	14·67	16·31	42·33	58·64	·07	·50
Average ..	88·53	5·67	21·21	14·58	16·37	42·16	58·53	·07	·52

The percentage composition of the three straws and of the coconut poonac on dry basis is given in table IV. Here too the averages for the three periods are given.

TABLE V

Digestibility co-efficients of Rice Straw and Coconut Poonac and Straw alone

1ST PERIOD

Untreated Straw

Consumed from :—	Bull No. 1						Bull No. 2					
	Dry matter	*Crude Protein*	*Ether extract*	*Crude fibre*	*N. free extract*	*Total carbohydrates*	*Dry matter*	*Crude protein*	*Ether extract*	*Crude fibre*	*N. free extract*	*Total carbohydrates*
	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.	gm.
Untreated Straw ..	2,812·0	70·95	21·80	959·8	1,198·0	2,157·8	2,828·0	71·33	21·93	965·2	1,205·0	2,170·2
Coconut Poonac ..	656·4	139·20	94·86	115·0	255·7	370·7	656·4	139·20	94·86	115·0	255·7	370·7
Total ..	3,468·4	210·15	116·66	1,074·8	1,453·7	2,528·5	3,484·4	210·53	116·79	1,080·2	1,460·7	2,540·9
Voided in faeces ..	2,100·0	114·90	31·59	460·3	877·0	1,337·3	1,944·9	110·00	27·83	392·4	766·1	1,158·5
Total digested ..	1,368·4	95·25	85·07	614·5	576·7	1,191·2	1,539·5	100·53	88·96	687·8	694·6	1,382·4
Digestibility co-efficient of whole ration ..	40	45	73	57	40	47	44	48	76	64	47	54
Digested from Coconut Poonac ..	538·2	118·30	94·86	52·90	209·7	262·6	538·2	118·30	94·86	52·9	209·7	262·6
Digested from Straw ..	830·2	—	—	561·60	367·0	928·6	1,001·3	—	—	634·9	484·9	1,119·8
Dig : co-efficient of Straw ..	30	0	0	59	31	43	35	0	0	66	40	52

Water Washed Straw

Consumed from :—	Bull No. 3						Bull No. 4					
Water washed straw ..	2,101·0	50·46	17·37	765·5	855·0	1,620·5	2,395·0	57·51	19·80	872·8	974·6	1,847·4
Coconut poonac ..	656·4	139·20	94·86	115·0	255·7	370·7	656·4	139·20	94·86	115·0	255·7	370·7
Total ..	2,757·4	189·66	112·23	880·5	1,110·7	1,991·2	3,951·4	196·71	114·66	987·8	1,230·3	2,218·1
Voided in faeces ..	1,714·5	104·20	25·31	354·3	703·5	1,057·8	1,915·2	104·10	27·43	414·0	810·0	1,224·0
Total digested ..	1,042·9	85·46	86·92	526·2	407·2	933·4	1,136·2	92·61	87·23	573·8	420·3	994·1
Dig : co-ef : of whole ration ..	38	45	77	60	37	47	37	47	76	58	34	45
Dig : from c : poonac ..	538·2	118·30	94·86	52·90	209·7	262·6	538·2	118·30	94·86	52·90	209·7	262·60
Dig : from Straw ..	504·7	—	—	473·30	197·5	670·8	598·0	—	—	520·90	210·6	731·50
Dig : co-ef. of straw alone ..	24	0	0	57	23	41	25	0	0	60	22	40

Lye Treated Straw

Consumed from :—	Bull No. 5						Bull No. 6					
Lye treated straw ..	2,321·0	58·97	18·48	1,026·0	1,903·6	1,929·6	2,580·0	65·56	20·53	1,141·0	1,005·0	2,146·0
Coconut poonac ..	656·4	139·20	94·86	115·0	255·7	370·7	656·4	139·20	94·86	115·0	255·7	370·7
Total ..	2,977·4	198·17	113·74	1,141·0	1,159·3	2,300·3	3,236·4	201·76	115·39	1,256·0	1,260·7	2,516·7
Voided in faeces ..	1,282·2	114·2	29·10	235·3	517·1	752·4	1,380·5	121·20	30·79	242·5	574·1	816·8
Total digested ..	1,695·2	83·97	84·24	905·7	642·2	1,547·9	1,855·9	83·56	84·60	1,013·5	686·6	1,700·1
Dig : co-ef of whole ration ..	57	42	74	79	55	67	57	41	73	81	55	68
Digested from c. poonac ..	538·2	118·3	94·86	52·90	209·7	262·6	538·2	118·3	94·86	52·90	209·7	262·6
Digested from lye tr. straw ..	1,157·0	—	—	852·8	432·5	1,285·3	1,317·7	—	—	960·6	476·9	1,437·5
Dig : co-ef. of straw alone ..	59	0	0	83	48	67	51	0	0	84	47	67

TABLE VI

Digestibility co-efficients of Straw and Coconut Poonac and Straw alone.

2ND PERIOD

Untreated Straw

Consumed from :—	*Bull No. 3*						*Bull No. 4*					
	Dry matter	*Crude Protein*	*Ether extract*	*Crude fibre*	*N. free extract*	*Total carbohydrates*	*Dry matter*	*Crude protein*	*Ether extract*	*Crude fibre*	*N. free extract*	*Total carbohydrates*
	gm.	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*
Untreated straw	2,847·0	89·48	18·25	1,047·0	1,096·0	2,143·0	3,587·0	112·80	23·00	1,319·0	1,514·0	2,833·0
Coconut poonac	652·3	140·30	95·44	106·2	273·3	379·5	652·3	140·30	95·44	106·2	273·3	379·5
Total	3,499·3	229·78	113·69	1,153·2	1,369·3	2,522·5	4,239·3	253·10	118·44	1,425·2	1,787·3	3,212·5
Voided in faeces	1,669·0	110·80	15·90	362·6	723·1	1,085·7	2,357·8	140·40	27·60	557·6	1,019·0	1,576·6
Total digested	1,830·3	118·98	97·79	790·6	646·2	1,436·8	1,881·5	112·70	90·84	867·6	768·3	1,635·9
Dig : co-ef. whole ration	52	52	86	69	47	67	44	45	77	58	43	51
Digested from coconut poonac	534·9	119·20	95·44	48·86	224·1	272·96	534·9	119·20	95·44	48·86	224·1	272·96
Digested from straw	1,295·4	—	2·35	741·74	422·1	1,163·84	1,346·6	—	—	818·74	544·2	1,362·94
Digestibility co-ef. of straw alone	46	0	12	70	39	54	38	0	0	62	36	48

Water Washed Straw

Consumed from :—	*Bull No. 5*						*Bull No. 6*					
Water washed straw	2,958·0	81·15	23·07	1,201·0	1,212·0	2,413·0	3,420·0	94·08	26·74	1,393·0	1,506·0	2,899·0
Coconut poonac	652·3	140·30	95·44	106·2	273·3	379·5	652·3	140·30	95·44	106·2	273·3	379·5
Total	3,610·3	221·45	118·51	1,307·2	1,485·3	2,792·5	4,081·3	234·38	122·18	1,499·2	1,779·3	3,278·5
Voided in faeces	1,952·8	120·60	18·59	464·4	832·7	1,297·1	2,264·0	137·00	34·91	543·2	975·2	1,518·4
Total digested	1,657·5	100·85	99·92	842·8	652·6	1,485·4	1,817·3	97·38	97·27	956·0	804·1	1,760·1
Digestibility co-ef : of who : ration	46	46	84	65	44	54	45	43	80	64	45	54
Digested from coconut poonac	534·9	119·20	95·44	48·86	224·1	272·96	534·9	119·20	95·44	48·86	224·1	272·96
Digested from straw	1,122·6	—	4·48	793·94	428·5	1,222·44	1,282·4	—	1·83	907·10	580·0	1,487·10
Digestibility co-ef. of straw alone	38	0	19	66	35	51	37	0	7	65	39	51

Lye Treated Straw

Consumed from :—	*Bull No. 1*						*Bull No. 2*					
Lye treated straw	2,387·0	69·84	17·39	1,063·0	955·8	2,018·8	2,686·0	70·68	19·55	1,195·0	1,075·0	2,270·0
Coconut poonac	652·3	140·30	95·44	106·2	273·3	379·5	652·3	140·30	95·44	106·2	273·3	379·5
Total	3,039·3	210·14	112·83	1,196·2	1,229·1	2,398·3	3,338·3	210·98	114·99	1,301·2	1,348·3	2,649·5
Voided in faeces	1,264·3	120·20	15·30	279·9	525·4	805·3	1,235·4	120·00	15·36	258·7	521·3	780·0
Total digested	1,775·0	89·94	87·53	889·3	703·7	1,593·0	2,102·9	90·98	99·63	1,042·5	827·0	1,869·5
Digestibility co. ef. of whole rt	58	43	86	76	57	66	63	43	87	80	61	70
Digested from coconut poonac	534·9	119·20	95·44	48·86	224·1	272·96	534·9	119·20	95·44	48·86	224·1	272·96
Digested from lye treated straw	1,240·1	—	2·09	840·44	479·6	1,320·04	1,568·0	—	40·19	993·64	602·09	1,596·5
Digestibility co.ef. of straw alone	52	0	12	79	50	65	58	0	21	83	56	70

TABLE VII

Digestibility Co-efficients of Rice, Straw and Coconut Poonac and Straw alone

3rd Period

Untreated Straw

Consumed from :—	*Bull No. 5*					*Bull No. 6*				
	Dry matter gm.	*Crude Protein* gm.	*Ether extract* gm.	*Crude fibre* gm.	*N. free extract* gm.	*Total carbohydrates* gm.	*Dry matter* gm.	*Crude protein* gm.	*Ether extract* gm.	*Crude fibre* gm.	*N. free extract* gm.	*Total carbohydrates* gm.
Untreated straw ..	3.590·0	83·25	31·54	1.319·0	1,505·0	2,824·0	3,906·0	90·58	34·31	1,435·0	1,638·0	3,073·0
Coconut poonac ..	669·3	140·10	98·22	109·2	277·8	387·0	669·3	140·10	98·22	109·2	277·8	387·0
Total ..	4,259·3	233·35	129·76	1,428·2	1,782·8	3,211·0	4,575·3	230·68	132·53	1,544·2	1,915·8	3,460·0
Voided from faeces	2,041·9	117·00	21·58	397·6	846·1	1,243·7	2,389·2	137·40	21·76	538·5	935·8	1,474·3
Total digested ..	2,217·4	106·35	108·18	1,030·6	936·7	1,967·3	2,186·1	93·28	110·77	1,005·7	980·0	1,985·7
Digestibility co-eff : of whole ration	52	48	83	72	53	61	48	41	84	65	51	57
Digested from Coconut poonac ..	543·1	119·1	98·22	50·2	237·8	288·0	543·1	119·10	98·22	50·2	237·8	288·0
Digested from untreated straw	1.674·3	—	—	980·4	698·9	1,679·3	1,643·0	—	—	955·5	742·2	1,697·7
Digestibility co-eff. of straw alone ..	47	0	6	74	46	59	42	0	0	66	45	55

Water Washed Straw

Consumed from :—	*Bull No. 1*					*Bull No. 2*				
Water Washed straw ..	3.270·0	72·51	31·54	1,277·0	1,373·0	2,650·0	3,316·0	73·53	31·99	1,295·0	1,392·0	2,687·0
Coconut poonac ..	669·3	140·10	98·22	109·2	277·8	387·0	669·3	140·10	98·22	109·2	277·8	387·0
Total ..	3.939·3	212·61	129·76	1,386·2	1,650·8	3,037·0	3,985·3	213·63	130·21	1,404·2	1,669·8	3,074·0
Voided from faeces	2,302·2	116·10	39·80	562·1	937·4	1,499·5	2,070·1	123·70	36·44	506·3	879·2	1,385·5
Total digested ..	1,637·1	96·51	89·96	824·1	713·4	1,537·5	1,915·2	89·93	93·77	897·9	790·6	1,688·5
Digestibility co-eff : whole ration	42	45	69	60	43	51	46	42	72	64	47	55
Digested from Coconut poonac ..	543·1	119·1	98·22	50·2	237·8	288·0	543·1	119·10	98·22	50·2	237·8	288·0
Digested from straw ..	1,094·0	—	—	773·9	475·6	1,249·5	1,372·1	—	—	847·1	552·8	1,400·5
Digestibility co-eff : straw	33	0	0	61	35	47	41	0	0	65	40	52

Lye Treated Straw

Consumed from '—	*Bull No. 3*					*Bull No. 4*				
Lye treated straw ..	2,873·0	69·35	28·48	1,211·0	1,117·0	2,328·0	2,711·0	65·43	26·88	1,143·0	1,054·0	2,197·0
Coconut poonac ..	669·3	140·10	98·22	109·2	277·8	387·0	6,69·3	140·10	98·22	109·2	277·8	387·0
Total ..	3,542·3	209·45	126·70	1,320·2	1,394·8	2,715·0	3,380·3	205·53	125·10	1,252·2	1,331·8	2,584·0
Voided in faeces ..	1,557·3	128·48	23·05	302·3	623·4	925·7	1,485·8	128·20	19·49	308·8	610·8	919·6
Total digested ..	1,985·0	80·97	103·65	1,017·9	771·4	1,789·3	1,894·5	77·33	105·61	943·4	721·0	1,664·4
Digestibility co-eff : whole ration	56	39	82	77	55	66	56	38	84	75	54	64
Digested from coconut poonac ..	543·1	119·10	98·22	50·2	237·8	288·0	543·1	119·1	98·22	50·2	237·8	288·0
Digested from straw ..	1,441·9	—	5·43	967·7	533·6	1,501·3	1,351·4	—	7·39	893·2	483·2	1,376·4
Digestibility co-eff ; Straw alone ..	50	0	19	80	48	34	50	0	27	78	46	63

TABLE VIII

Digestibility Co-efficients of the Whole Ration

UNTREATED STRAW

	Dry matter	*Crude Protein*	*Ether extract*	*Crude Fibre*	*Notrogen free extractives*	*Total carbohydrates*
Period	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3
	40—52—52	45—52—48	73—86—83	57—69—72	40—47—53	47—67—61
	44—44—48	48—45—41	76—77—84	64—58—65	47—43—51	54—51—57
Mean	46·67	46·50	79·83	64·17	46·83	56·17

WATER WASHED

Period	61— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3
	38—46—42	45—46—45	77—84—69	60—65—60	37—44—43	47—54—51
	37—45—46	47—42—42	76—80—72	58—64—64	34—45—47	45—54—55
Mean	42·33	44·50	76·33	61·83	41·67	51·00

LYE WASHED

Period	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3
	57—58—56	42—43—39	74—86—82	79—76—77	55—57—55	67—66—66
	57—63—56	41—43—38	73—87—84	81—80—75	55—61—54	68—70—64
Mean	57·53	41·00	81·00	78·00	56·17	66·83

Digestibility Co-efficients of the Straws alone

UNTREATED STRAW

Period	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3
	30—46—47	00—00—00	00—12—00	59—70—74	31—39—46	43—54—59
	35—38—42	00—00—00	00—00—00	66—62—66	40—36—45	52—48—55
Mean	39·69	00	2	66·17	39·50	51·83

WATER WASHED STRAW

Period	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3
	24—38—33	00—00—00	00—19—00	57—66—61	23—35—35	41—51—47
	25—37—41	00—00—00	00— 7—00	60—65—65	22—39—40	40—51—52
Mean	33·00	00	4	62·33	32·33	47·00

LYE WASHED

Period	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3	1— 2— 3
	50—52—50	00—00—00	00—12—19	89—79—80	48—50—48	67—65—64
	51—58—50	00—00—00	00—21—27	84—83—78	47—56—46	67—70—63
Mean	51·83	00	13	81·17	49·17	66·00

The digestibility co-efficients in the whole ration and in the straw alone are shown in tables V, VI and VII and in table VIII the digestibility co-efficients are summarised.

The digestibility co-efficients of the various constituents as shown in table VIII have been statistically analysed. The analysis of variance of these are shown in tables IX and X the whole ration and the straws alone being treated separately. It was not considered necessary to effect a transformation of the digestibility co-efficients before statistically analysing them.

TABLE IX

Whole Ration

Analysis of Variance of Digestibility Co-efficients

Total treatments :—	*df.*	*Dry Matter* S. S.	*Dry Matter* M. S.	*Dry Matter* Variance Ratio	*Crude Fibre* S. S.	*Crude Fibre* M. S.	*Crude Fibre* Variance Ratio	*Nitrogen-free extract* S. S.	*Nitrogen-free extract* M. S.	*Nitrogen-free extract* Variance Ratio
Animal batches and straw	8	931·45	116·43	15·08*	1,028·00	128·50	8·76*	869·12	108·64	17·47*
Straw	2	767·45	383·73	49·70*	916·33	458·17	31·23*	648·12	324·06	52·10*
Animal batches	2	40·45	20·23	2·62	82·33	41·17	2·81	98·78	49·39	7·94†
Interaction	4	123·55	30·89	4·00†	29·34	7·34	·50	122·22	30·56	4·91†
Error	9	69·50	7·72	—	132·00	14·67	—	56·00	6·22	—
Total	17	1,000·95	—	—	1,160·00	—	—	925·12	—	—

	Dry Matter Untreated Straw	*Dry Matter* Water Washed Straw	*Dry Matter* Lye treated Straw	*Dry Matter* Sig. diff.	*Crude Fibre* Untreated Straw	*Crude Fibre* Water Washed Straw	*Crude Fibre* Lye treated Straw	*Crude Fibre* Sig. diff.	*Nitrogen-free extract* Untreated Straw	*Nitrogen-free extract* Water Washed Straw	*Nitrogen-free extract* Lye treated Straw	*Nitrogen-free extract* Sig. diff.
Total for 6 animals	280	254	347	—	385	371	468	—	281	250	337	—
Mean per animal	46·67	42·33	57·83	3·63	64·17	61·83	78·00	5·00	46·83	41·67	56·17	3·26
Percentage	100	90·70	123·91	7·78	100	96·35	121·55	7·79	100	88·98	119·94	6·96

Analysis of Variance of Digestibility Co-efficients—*contd.*

Total treatment :—	*df.*	*Total carbohydrate* S. S.	*Total carbohydrate* M. S.	*Total carbohydrate* Variance Ratio	*Protein* S. S.	*Protein* M. S.	*Protein* Variance Ratio	*Ether Extract* S. S.	*Ether Extract* M. S.	*Ether Extract* Variance Ratio
Animal batches and straw	8	964·78	120·60	6·00*	137·00	17·83	2·23	473·39	59·17	8·66*
Straw	2	782.11	391·06	19·45*	93·00	46·50	6·06†	70·72	35·17	5·18†
Animal batches	2	42·78	21·39	1·06	4·00	2·00	·26	33·39	16·70	2·45
Interaction	4	139·89	34·97	1·74	40·00	10·00	1·30	369·28	92·32	13·52*
Error	9	181·00	20·11	—	69·00	7·67	—	61·50	6·83	—
Total	17	1,145·78	—	—	206·00	—	—	534·89	—	—

	Total carbohydrate Untreated Straw	*Total carbohydrate* Water Washed Straw	*Total carbohydrate* Lye treated Straw	*Total carbohydrate* Sig. diff.	*Protein* Untreated Straw	*Protein* Water Washed Straw	*Protein* Lye treated Straw	*Protein* Sig. diff.	*Ether Extract* Untreated Straw	*Ether Extract* Water Washed Straw	*Ether Extract* Lye treated Straw	*Ether Extract* Sig. diff.
Total for 6 animals	337	306	401	—	279	267	246	—	479	458	486	—
Mean per animal	56·17	51·00	66·83	5·86	46·50	44·50	41·00	3·62	79·83	76·33	81·00	3·41
Percentage	100	90·80	118·98	10·43	100	95·70	88·17	7·78	100	95·62	101·47	4·27

* Sig. at 1 per cent.

† Sig. at 5 per cent.

TABLE X

Analysis of Variance of Digestibility Co-efficients—Straw Alone

	df.	*Dry Matter*			*Crude Fibre*			*Nitrogen-Free-Extract*			*Total Carbohydrates*		
		S. S.	*M. S.*	*Variance Ratio*	*S. S.*	*M. S.*	*Variance Ratio*	*S. S.*	*M. S.*	*Variance Ratio*	*S. S.*	*M. S.*	*Variance Ratio*
Total treatments :—													
Animal batches and straw	8	1,502·00	187·75	15·57*	1,316·00	164·50	13·22*	1,303·00	163·00	16·86*	1,410·44	176·31	17·15*
Straw	2	1,094·33	547·17	45·37*	1,189·00	594·50	47·79*	856·50	428·25	44·29*	1,170·11	585·06	56·91*
Animal batches	2	85·33	42·67	3·54	90·30	45·15	3·63	201·30	100·65	10·41*	133·44	66·72	6·49†
Interaction	4	322·34	80·59	6·68*	36·70	9·18	0·74	245·20	61·30	6·34†	106·89	26·72	2·60
Error	9	108·50	12·06	—	112·00	12·44	—	87·00	9·67	—	92·50	10·28	—
Total	17	1,610·50	—	—	1,428·00	—	—	1,390·00	—	—	1,502·94	—	—

	Untreated Straw	*Water Washed Straw*	*Lye Treated Straw*	*Sig. diff.*	*Untreated Straw*	*Water Washed Straw*	*Lye Treated Straw*	*Sig. diff.*	*Untreated Straw*	*Water Washed Straw*	*Lye Treated Straw*	*Sig. diff.*	*Untreated Straw*	*Water Washed Straw*	*Lye Treated Straw*	*Sig. diff.*
Total for 6 animals	238	198	311	—	397	374	487	—	237	194	295	—	311	282	396	—
Mean per animal	39·67	33·00	51·83	4·53	66·17	62·33	81·17	4·61	39·50	32·33	49·17	4·06	51·83	47·00	66·00	4·19
Percentage	100	83·19	130·65	11·42	100	94·20	122·67	6·97	100	81·85	124·48	10·28	100	90·68	127·34	8·08

* Sig. at 1 per cent.

† Sig. at 5 per cent.

The results of the statistical analysis show that in the *whole ration* the lye treated straw is significantly superior to both the untreated and the water washed straw in dry matter, crude fibre, nitrogen-free-extract and total carbohydrates. In ether extract lye treated straw is significantly better than water washed straw but there is no significant difference between it and the untreated straw. It is however noteworthy that the protein in the untreated straw is significantly superior to that in the lye treated straw. There is no significant difference between the lye treated and water washed. Untreated straw is significantly better than water washed straw in dry matter, nitrogen-free-extract and ether extract but there is no significant difference between untreated and water washed straw in the other three constituents.

In the *straw-alone-figures* the lye treated is significantly superior to both water washed and untreated straw in dry matter, crude fibre, nitrogen-free-extract and total carbohydrates. The untreated straw is significantly better than the water washed straw in dry matter, nitrogen-free-extract and total carbohydrates, but in the case of crude fibre there is no difference.

The differences in the animal batches are eliminated by the design of the experiment and therefore the effect of water washing and lye treatment on the digestibility of the straw can be clearly gauged. In the digestibility of the straw alone which really is of primary importance, the protein and fat may be considered totally undigested for all purposes. The carbohydrate fraction is therefore all that has to be considered in the nutritive value of the straws. The total digestible carbohydrate content of the untreated, water washed and lye treated straws are 40·22 per cent., 37·57 per cent. and 54·71 per cent. respectively. This means that lye treated straw has increased the digestibility of the total carbohydrate fraction by 36 per cent. Here it is abundantly evident that lye treatment has significantly improved the straw while water washing has significantly decreased the value of the straw.

TABLE XI

Balance for Nitrogen

UNTREATED STRAW

	Intake from		*Total Intake*	*Output from*		*Total output*	*Balance*
	Straw	*Poonac*		*Faeces*	*Urine*		
Bull No. 1	11·24	22·27	33·51	18·38	22·64	41·02	— 7·51
Bull No. 2	11·41	22·27	33·68	17·60	18·70	36·30	— 2·62
Bull No. 3	14·32	22·45	36·77	17·73	19·00	36·73	— 0·04
Bull No. 4	18·05	22·45	40·50	22·46	18·96	41·42	— 0·92
Bull No. 5	13·32	22·42	35·74	18·72	16·18	36·90	— 1·16
Bull No. 6	14·49	22·42	36·91	21·98	18·43	40·41	— 3·50

WATER WASHED

	Intake from		Total Intake	Output from		Total output	Balance
	Straw	Poonac		Faeces	Urine		
Bull No. 3	8·07	22·27	30·34	16·67	21·05	37·72	— 7·38
Bull No. 4	9·20	22·27	31·47	16·66	21·07	37·73	— 6·26
Bull No. 5	12·98	22·45	35·43	19·30	18·54	38·17	— 2·74
Bull No. 6	15·05	22·45	37·50	21·92	18·17	40·09	— 2·59
Bull No. 1	11·60	22·42	34·02	18·58	18·43	37·01	— 2·99
Bull No. 2	11·76	22·42	34·23	19·79	20·02	39·81	— 5·58

LYE WASHED

Bull No. 5	9·44	22·27	31·71	18·48	12·53	31·01	+ 0·70
Bull No. 6	10·49	22·27	32·76	19·39	12·69	32·08	+ 0·68
Bull No. 1	11·17	22·45	33·62	19·23	13·30	32·53	+ 1·09
Bull No. 2	11·31	22·45	33·76	19·20	12·31	31·51	+ 2·25
Bull No. 3	11·10	22·42	33·52	20·56	9·87	30·43	+ 3·09
Bull No. 4	10·47	22·42	32·89	20·51	10·95	31·46	+ 1·43

TABLE XII

Balance for Calcium

UNTREATED STRAW

	Intake from		Total Intake	Output from		Total output	Balance
	Straw	Poonac		Faeces	Urine		
Bull No. 1	6·22	0·39	6·61	11·76	0·20	11·96	— 5·35
Bull No. 2	6·25	0·39	6·64	11·86	0·36	12·22	— 5·58
Bull No. 3	6·58	0·46	7·04	10·02	0·46	10·48	— 3·44
Bull No. 4	8·29	0·46	8·75	12·31	0·46	12·77	— 4·02
Bull No. 5	7·04	0·45	7·49	9·82	0·09	9·91	— 2·42
Bull No. 6	7·66	0·45	8·11	11·40	0·09	11·49	— 3·38

WATER WASHED STRAW

Bull No. 3	7·94	0·39	8·33	10·46	0·94	11·40	— 3·07
Bull No. 4	9·05	0·39	9·44	11·11	0·56	11·67	— 2·23
Bull No. 5	9·02	0·46	9·48	12·73	0·71	13·44	— 3·96
Bull No. 6	10·46	0·46	10·92	14·09	0·71	14·80	— 3·88
Bull No. 1	9·02	0·45	9·47	10·39	0·48	10·87	— 1·40
Bull No. 2	9·15	0·45	9·60	10·86	0·78	11·64	— 2·04

LYE TREATED STRAW

	Intake from		Total Intake	Output from		Total output	Balance
	Straw	Poonac		Faeces	Urine		
Bull No. 5	11·51	0·39	11·90	10·51	0·50	11·01	+ 0·89
Bull No. 6	12·80	0·39	13·19	10·49	0·60	10·09	+ 2·10
Bull No. 1	9·84	0·46	10·30	8·41	0·71	9·12	+ 1·18
Bull No. 2	11·08	0·46	11·54	8·36	0·71	9·07	+ 2·47
Bull No. 3	10·83	0·45	11·28	10·30	0·13	10·43	+ 0·85
Bull No. 4	10·22	0·45	10·67	6·65	0·16	6·81	+ 3·86

TABLE XIII

Balance for Phosphorus

UNTREATED STRAW

	Intake from		Total Intake	Output from		Total output	Balance
	Straw	Poonac		Faeces	Urine		
Bull No. 1	3·37	3·49	6·86	6·72	0·16	6·88	+ 0·02
Bull No. 2	3·39	3·49	6·88	6·22	0·19	6·41	+ 0·47
Bull No. 3	3·13	3·38	6·51	7·68	0·11	7·79	— 1·28
Bull No. 4	3·95	3·38	7·33	8·96	0·10	9·06	— 1·73
Bull No. 5	3·95	3·33	7·28	7·35	0·15	7·50	— 0·22
Bull No. 6	4·30	3·33	7·63	7·89	0·17	8·06	— 0·43

WATER WASHED STRAW

Bull No. 3	6·93	3·49	10·42	5·32	0·08	5·40	+ 5·02
Bull No. 4	7·90	3·49	11·39	5·17	0·09	5·26	+ 6·13
Bull No. 5	8·87	3·38	12·25	6·45	0·11	6·56	+ 5·69
Bull No. 6	10·28	3·38	13·66	9·96	0·10	10·06	+ 3·60
Bull No. 1	10·46	3·33	13·79	8·52	0·15	8·67	+ 5·12
Bull No. 2	10·61	3·33	13·94	7·04	0·11	6·79	+ 7·15

LYE TREATED STRAW

Bull No. 5	1·76	3·49	5·25	4·36	0·13	4·49	+ 0·76
Bull No. 6	2·06	3·49	5·55	4·01	0·13	4·14	+ 1·41
Bull No. 1	2·15	3·38	5·53	5·29	0·12	5·41	+ 0·12
Bull No. 2	2·41	3·38	5·79	5·80	0·10	5·90	— 0·11
Bull No. 3	2·30	3·33	5·63	4·67	0·16	4·83	+ 0·80
Bull No. 4	2·17	3·33	5·50	4·90	0·15	5·05	+ 0·45

Tables XI, XII, and XIII show the nitrogen, calcium and phosphorus balances. The results show that the lye treated straw has a positive balance for all three constituents while in the water washed and untreated straw the nitrogen and calcium are negative in both. The phosphorus is negative in the untreated straw but positive in the water washed straw. This may be expected as there is a big increase in the phosphorus of the water washed straw.

TABLE XIV

Excretion of Urine per Day

Untreated		*Water Washed*		*Lye Treated*	
Bull No. 1 ..	2785	Bull No. 3 ..	1354	Bull No. 5 ..	2201
Bull No. 2 ..	2431	Bull No. 4 ..	1512	Bull No. 6 ..	2456
Bull No. 3 ..	2405	Bull No. 5 ..	1144	Bull No. 1 ..	2657
Bull No. 4 ..	3186	Bull No. 6 ..	1453	Bull No. 2 ..	2948
Bull No. 5 ..	2693	Bull No. 1 ..	1186	Bull No. 3 ..	3493
Bull No. 6 ..	3364	Bull No. 2 ..	1678	Bull No. 4 ..	3476
Average ..	2810		1389		2872

There is no excessive urination under any of the three straw treatments nor were the animals emaciated due to the deficiency in the retention of Calcium and Phosporus. The author (6) had noticed a very marked emaciation in the experimental animals in a trial he carried out at Izatnagar on the digestibility of maize husk where the ration fed was deficient in phosphorus. When in the next trial the deficiency of phosphorus was made good no such emaciation was noticed. Further whereas in the first trial the nitrogen calcium and phosphorus were all negative in the absence of sufficient phosphorus with the addition of the phosphorus the retention of all three of these constituents were positive. Cabery (7), also did not notice any excessive urination or diuresis, in his trials with paddy straw.

Table XIV shows the amounts of urine excreted daily under the three different treatments. The average for each treatment is given at the bottom of the table. The amount of urine excreted under the untreated straw treatment, which cannot be considered excessive, is practically the same as that under lye treatment. But the urination under the water washed treatment is almost half of the others which indicates that water washing of the straw depresses the excretion of urine.

TABLE XV

Percentage Moisture in Faeces

Untreated		*Water Washed*		*Lye Treated*	
Bull No. 1	77·15	Bull No. 3	73·60	Bull No. 5	79·15
Bull No. 2	77·05	Bull No. 4	75·17	Bull No. 6	79·88
Bull No. 3	79·96	Bull No. 5	76·71	Bull No. 1	81·85
Bull No. 4	79·11	Bull No. 6	77·15	Bull No. 2	80·47
Bull No. 5	73·60	Bull No. 1	77·70	Bull No. 3	75·10
Bull No. 6	76·05	Bull No. 2	79·02	Bull No. 4	80·34
Average	77·15		76·54		79·47

Table XV gives the percentage moisture in the faeces under the three different treatments and it is seen that the faeces from the lye treated straw treatment has the highest moisture.

It is possible that Sinhala cattle living on a lower mineral intake for centuries had attained a lower equilibrium for these minerals. Thus the experimental animals were not adversely affected as animals bred at a higher mineral level would have been.

TABLE XVI

Utilization of Carbohydrates in Straw—per all six Animals for each Treatment per Day

	Total straw consumed	*Total carbohydrates in the straw consumed*	*Total carbohydrates Digested*
	gms.	*gms.*	*gms.*
Untreated straw	19,570	15,184	6,107
Water washed straw	17,469	13,963	5,246
Lye treated straw	15,558	12,897	7,056

Table XVI gives the amounts of straw consumed from the three treatments, the equivalent of the straw consumed in total carbohydrates and the amount of carbohydrate digested. It is seen that although the untreated straw is consumed the most, the highest amount of digestible carbohydrates has been derived from the lye treated straw. It is not the amount consumed but the actual amount digested that is the criterion by which a feedingstuff can be judged.

Unfortunately, although the lye treatment of straw significantly increases its nutritive value, it is not a method that can be adopted by the average Ceylon villager. But when the plant for the large scale processing of animal food is established the production of lye treated straw economically

Plate 1.—A Bull with the digestibility harness on.

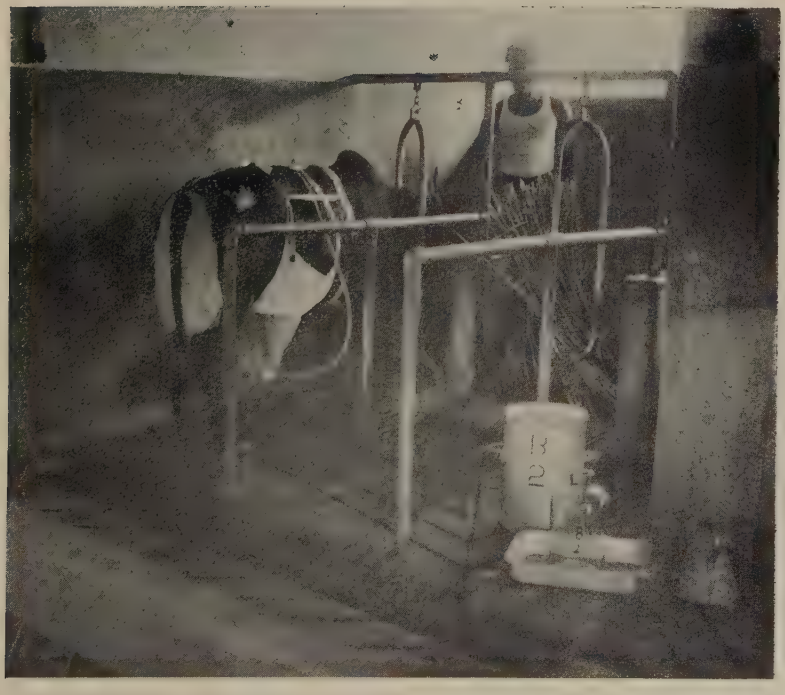

Plate 2.—Two Metabolism Stalls.

Plate 3.—The Trial in Progress.

should be possible. It may be worthwhile investigating the production of a lye treated straw fortified with a nitrogen rich material like urea. A product of this nature will go a long way to ease the scarcity of animal feedingstuffs in the Island.

SUMMARY

Both lye treatment and water washing remove the excessive amounts of potassium and oxalates which hinder the assimilation of calcium. But while lye treatment removes almost 90 per cent., water washing removes only about 50 per cent. and that too not consistantly.

The carbohydrate fraction which is the most valuable portion of the straw is significantly increased by lye treatment.

Lye treatment significantly increases the digestibility of the carbohydrate fraction of paddy straw while water washing decreases it. The increase of the total digestible carbohydrates by lye treatment is 36 per cent.

No diuresis was noticed under any of the three straw treatments adopted in this trial.

Though the consumption was highest in the untreated straw and lowest in the lye treated the amount of the carbohydrates actually digested was highest in the lye treated straw.

ACKNOWLEDGMENTS

I have to thank Mr. D. M. Rodrigo for valuable help in the statistical analysis of the results.

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Viability of Citrus Seeds

BY

A. V. RICHARDS

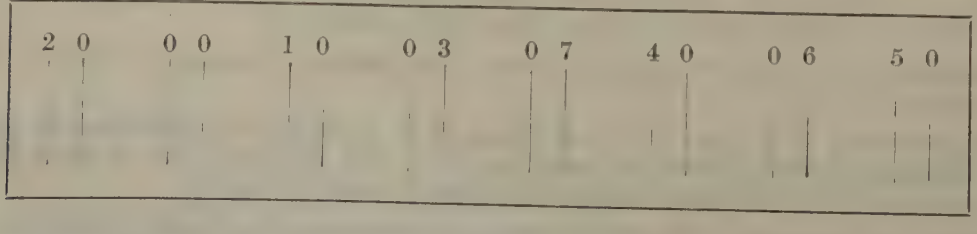
PRELIMINARY trials on the germination of citrus seeds indicate that in most citrus varieties the seed loses viability rapidly on storage at normal air temperature of 78° F. to 80° F. and has to be sown immediately after extraction from the fruit to get the best results.

The common citrus varieties such as the Bibile Sweet Orange and the acid country lime, which is not unlike the British Guiana or West Indian lime, are generally grown from seed which is polyembryonic. Each polyembryonic seed contains two or more embryos of which one is the sexual embryo produced as a result of fertilization and the others the asexual or nucellar embryos produced as vegetative buds from the parent nucellar tissue. These nucellar embryos are all identical with the seed parent in their genetic make-up and grow at the expense of the sexual embryo which is often smothered in the early stages. If the sexual embryo survives it grows into a weak hybrid seedling, although in rare instances a seedling exhibiting marked hybrid vigour may be produced which is easily spotted as a variant type in the seed bed. But even these polyembryonic seeds retain viability only for very short periods and have to be sown immediately after extraction.

The acid country lime which is a rich source of vitamin C, the specific for scurvy, makes a refreshing drink and is a popular flavouring agent for curries in nearly every home in Ceylon. But in recent years the fruits have become scarce and expensive during the greater part of the season owing to the death of many trees in home gardens and failure to replant in time. An extensive lime planting drive has therefore been organized to encourage the production of limes in home gardens, and the opportunity has been taken to test the viability of seeds extracted from the first consignment of selected fruits obtained for the planting drive.

THE LAY-OUT OF THE TRIAL

The Randomized Block design with 5 replications was used, and in each seed bed forming a block 8 double rows were marked at random as follows, 0 denoting seed row planted immediately after extraction, and the others 1 day, 2 days, &c. after extraction.



Trash was burnt on the surface of the seed beds to kill off damping off fungus and other disease organisms.

Seeds were extracted from 750 selected fruits, and 100 good seeds were planted immediately after extraction in each double row selected at random in each of the five blocks, making in all a total of 500 seeds. The remaining seeds were stored at normal air temperature and planted daily at the rate of 50 seeds in each row in a pair selected at random in each of the blocks. The other row in the pair was also planted daily with 50 seeds immediately after extraction from fruits reserved for the purpose, the total number of seeds planted in the trial being 4,000.

Germination counts were taken daily for over 5 weeks till germination was complete. Only the number of seeds that germinated was counted and not the number of seedlings since some polyembryonic seeds produced more than one seedling and the weak seedlings eventually died. The results are given in the following table :—

Germination Counts—Country Lime

Date of Sowing	*Treatments*	*Mean number germinated*	*Percentage germination*
26.3.52	Immediately after extraction	44·0	88·0
27.3.52	1 day after extraction	41·4	82·8
28.3.52	2 days do.	39·0	78·0
29.3.52	3 do.	35·0	70·0
30.3.52	4 do.	35·2	70·4
31.3.52	5 do.	33·2	66·4
1.4.52	6 do.	28·2	56·4
2.4.52	7 do.	27·4	54·8

The statistically significant difference in the mean number germinated being 3·7 it is clear that there is a definite falling off in viability of seed from the second day onwards after extraction. Seed planted daily immediately after extraction has given the best germination even though planting was done under weather conditions varying from day to day.

Similar results have been obtained with Bibile Sweet Orange seed planted immediately after extraction and at daily intervals for 21 days in a replicated trial.

The following are the germination percentages :—

Germination Counts—Bibile Sweet Orange

(Date of sowing: April 30, 1952.)

Days after extraction	*Percentage germination*
0 immediately after extraction	76·8
1 day after extraction	73·6
2 days after extraction	70·0
3 days after extraction	67·2
4 days after extraction	64·4
5 days after extraction	59·6

Days after extraction		*Percentage germination*
6	days after extraction ..	56·8
7	,, ..	52·4
8	,, ..	50·0
9	,, ..	54·0
10	,, ..	49·2
11	,, ..	50·0
12	,, ..	48·4
13	,, ..	45·2
14	,, ..	42·4
15	,, ..	40·4
21	,, ..	38·4

The significant difference is 7·2.

DISCUSSION

The preliminary germination studies show clearly that seeds of both country lime and Bibile Sweet Orange show marked reduction in viability when stored at normal air temperature of 78° F. to 80° F. for more than about three days after extraction, and that after one week's storage only about 50 per cent. of the seeds germinate.

But according to Webber (1948) citrus seed could be stored for longer periods if it is mixed with equal parts of ground charcoal and stored in tight wooden boxes or tin containers in a damp cool place at 38° F. to 55° F. Trials are in progress to determine the extent to which the viability could be retained by provision of cold storage, since mixing with charcoal alone at air temperature does not seem to make appreciable difference.

Seeds which have not been washed properly after extraction and treated with copper fungicide and surface dried tend to become mouldy, and show poor germination. Seed from rotten fruits also fail to germinate satisfactorily.

In the absence of cold storage facilities the best results are obtained if the seeds are treated with a copper fungicide immediately after extraction and planted within two to three days after being surface dried quickly in the open.

ACKNOWLEDGMENT

Thanks are due to Mr. J. K. Gnanaratnam and Mr. A. L. Gunasekera, Agricultural Instructors attached to the Horticultural Division for assistance in setting down the trials and taking germination records.

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The Tapping of Papaya for Papain

BY

C. CHARAVANAPAVAN

PAPAIN is extracted from green papaya fruits at a full grown stage by lancing them longitudinally. The wet latex that exudes is collected and dried.

The methods of cultivation of papaya and the production of papain are described in the Tropical Agriculturist, 1927, Volume 68, page 3, and the revised leaflet No. 44 of the Department of Agriculture, Ceylon. Further information on the production of superior quality papain is published in the Tropical Agriculturist, 1945, Volume 101, page 72.

Owing to the lack of information on yields of papain in relation to methods of tapping, an experiment was conducted statistically to ascertain the optimum conditions under which maximum yields of papain could be obtained.

DESIGN OF EXPERIMENT

An extent of flat land at the Experiment Station, Peradeniya, equal to one acre, suitable for growing papaya, was planted with Botanist's selection C. P. 124 with spacings 10 feet by 10 feet, giving a total number of about 400 trees. The area was divided into 6 blocks with 4 randomized plots per block consisting of 3 trees per plot. A guard row of trees was left round the area. A total of 72 trees with typical female characteristics were selected for the tapping trials. Bi-weekly tappings were compared with weekly tappings and three lancings were compared with 8 lancings.

The green fruits in the full grown stage were tapped regularly in the early hours of the morning, from about 6 a.m. to 10 a.m. The latex was collected in weighed utensils and dried and weighed. The tapping was continued for 8 weeks. The following are the results :—

Yields of Dried Papain in Grammes

Blocks	*Bi-weekly 3 lancings*	*Bi-weekly 8 lancings*	*Weekly 3 lancings*	*Weekly 8 lancings*	*Block Totals*
1 ..	40·55	74·87	33·29	42·16	190·87
2 ..	68·79	87·11	30·26	52·82	238·98
3 ..	81·66	124·12	54·03	46·90	306·71
4 ..	54·72	22·95	29·32	25·63	132·62
5 ..	31·11	57·25	20·65	43·92	152·93
6 ..	24·67	33·61	11·24	42·50	112·02
Treatment Totals ..	301·50	399·91	178·79	253·93	1,134·13
Average Yields ..	50·25	66·65	29·79	42·32	189·02

Statistical Data

	DF	*Sum of Squares*	*Mean Squares*	*F*	*F/.05 (from Table)*
(*a*) Total	23	15070·64	655·25		
(*b*) Blocks	5	6691·65	1338·33		
(*c*) Treatments	3	4286·59	1428·86	5·24	3·29
(*d*) Bi-weekly against weekly	1	3009·04	3009·04	11·02	4·54
(*e*) 3 lancings against 8 lancings	1	1255·93	1255·93	4·60	4·54
(*f*) Interaction between (*d*) and (*e*)	1	21·62	21·62	·07925	4·54
(*g*) Error	15	4092·40	272·83		

F test applied to (*c*), 5·24 is greater than 3·29 at probability (·05), and therefore the experiment is significant.

F test applied to (*d*), 11·02 is greater than 4·54 at probability (·05).

F test applied to (*e*), 4·60 is greater than 4·54 at probability (·05).

F test applied to (*f*), ·07925 is less than 4·54 at probability (·05).

Significant difference of totals is equal to 172·44.

Therefore yields for bi-weekly tappings are significantly greater than yields for weekly tappings. Also 8 lancings give significantly greater yields than 3 lancings.

Interaction is not significant.

CONCLUSIONS

According to the results obtained from 8 weeks' tappings it is evident that bi-weekly tappings would give proportionately greater yields and therefore can be recommended as a satisfactory practice.

Although 8 lancings have given significant increases in yields, the proportionate increases are not substantial enough to justify the extra time and labour involved in administering the 8 lancings to a fruit. Moreover, as a green fruit can be tapped over a period of 3 weeks or more, it would be advisable to apply only a few incisions at a time so that sufficient space is available on the fruit to continue the lancings over a longer period, until the fruit becomes ripe and ceases to give latex. Hence three lancings with bi-weekly tappings would be the most economical to practise.

ACKNOWLEDGMENTS

I am grateful to Mr. D. M. Rodrigo of the Chemical Division for working out the statistical data. I have also to thank Mr. Y. Elikawela of the School of Agriculture for Girls, Kundasale, for assisting in the field experiment.

DEPARTMENTAL NOTES

Grasses and Legumes

BY

W. R. C. PAUL

THERE are two ways in which fresh grass can be used to feed cattle :— (1) By direct *grazing* in cultivated pastures or on natural swards, (2) by *soiling* which involves the cutting of the green herbage and carting it daily to the farmstead for feeding. In temperate regions, the former is the established practice while in the tropics the latter is the commoner method.

Soiling is appropriate where land is limited and the stock few, particularly with European breeds, which at the lower elevations need protection against sun and parasites. It has, however, the disadvantage in that the cost of the labour in cutting, transporting and feeding the material to the stock is a heavy item which is dispensed with when animals graze on pasture. The nutritive value of the tall and tufted perennial grasses which are used for soiling and are popularly called *fodder grasses* is lower than that of the leafy types of *pasture grasses* though they are more easily grown and give heavy yields of cut fodder. Cattle are, however, not able to consume more than about 80 lb. a day of such cut fodders whereas on pastures the daily consumption may be as much as 125 lb.

The chief fodder grasses in Ceylon and in most parts of the tropics are *Guinea* and *Napier*. They were introduced several years ago and are now widely grown except in the wet highlands at elevations above 5,000 feet where the temperature is too low and frost damage is severe. By interplanting a few legumes, so that both are cut together, the mixture will provide a forage of better nutritive value. The legume will also help to improve the nitrogen content of the soil. The following are suitable legumes to be grown between the rows of fodder grasses :—

Stylo (*Stylosanthes gracilis* H. B. and K.) except in the dry zone.

Centro (*Centrosema pubescens Benth.*)

Desmodium limense var. *Sandwicense* (E. Meyr.)

Indigofera endecaphylla Jacq.

It should be noted that as the plants age their protein content falls while the fibre content rises and so cuttings should be taken at as short intervals as possible.

Cultivated pastures are of more recent introduction in Ceylon. They were first attempted early in 1946 in the Agricultural Stations of the wet lowlands. Although it is generally considered that good pasture requires a cool climate with a well distributed rainfall—and such conditions obtain only in certain areas of temperate countries—some type of pasture can be raised in the different zones of the Island, the better pastures naturally at the higher elevations.

To be of value, pastures should contain a mixture of grasses, legumes, and some miscellaneous herbs. The grasses provide some part of the protein, the legumes a greater part of it and the herbs, the mineral salts. These are the most important food requirements in a pasture. The proportions of the three components at planting time should be :—

Grasses	..	50 per cent.
Legumes	..	45 per cent.
Herbs	..	5 per cent.

With grazing, however, the proportions change and weeds, including inferior grasses, inevitably come in. This depends on the system of management and the fertility level of the soil. The following percentages represent the change that takes place in an average pasture after several grazings :—

Grasses	..	33 per cent.
Legumes	..	20 per cent.
Inferior Grasses	..	20 per cent.
Herbs	..	5 per cent.

Too high a proportion of legumes is undesirable as it tends to cause scouring in animals and therefore grasses of high protein content are valued. The more leafy the strain of grass and the younger the growth the higher its protein value. Legumes are also richer in calcium and phosphorus than grasses. Herbs are generally deeper rooted and are therefore able to bring up the mineral salts from the lower layers of the soil. They also provide a variety in the diet of the grazing animal.

The problem in Ceylon has been to find suitable grasses which when grown in pastures will be leafy (and not flower prematurely), palatable, and persistent and will produce viable seed. Few local grasses fulfil these conditions and trials are in progress with several introduced grasses, a few of which appear promising.

The selection of suitable legumes has not proved so difficult. A few good species both local and introduced are now known.

The best species that have so far been found are the following :—

Grasses—

(1) Molasses or the million dollar grass, (*Melinis minutiflora* Beauv.) for all zones.

(2) *Brachiaria brizantha* Stapf. for all zones.

(3) *Eriochloa procera* (Retz) C. E. Hubbard for the wet lowland zone.

Unfortunately, there are no popular names for the 2nd and 3rd grasses.

There are indications that for the wet highlands, rye grass and cocksfoot are the most suitable.

Legumes—

Wet highlands (above 4,000 ft.)—Red clover which is an annual for the first year; subterranean and white clovers later.

Wet lowlands and uplands :—*Stylosanthes gracilis* H. B. and K., *Indigofera endecaphylla* Jacq., *Alysicarpus vaginalis* D.C. (Singh. *aswenna*).

Dry lowlands :—*Indigofera endecaphylla* Jacq., *Alysicarpus vaginalis* D.C. and *A. rugosus* D.C.

Herbs—all zones other than the wet highlands :—

Ipomoea cymosa R. S. (Singh. *kiri madu*)

Asystasia gangetica T. (Singh. *puruk*)

It is very necessary that before a pasture can be planted the land should be thoroughly prepared as otherwise competition from weeds can be severe, particularly mimosa which is difficult to eradicate once it invades a pasture. The soil should, therefore, be repeatedly worked with a harrow or cultivator to destroy all weeds. An application of compost at 2–5 tons per acre will be useful and, in addition, a fertiliser mixture should be applied, before planting such as :—

Sulphate of ammonia	.. 1 cwt.
Conc. superphosphate	.. ½ cwt.
Muriate of potash	.. ¼ cwt.

The seed of the various components can be mixed and broadcast. Grazing can commence only about 2 months after planting and, thereafter, rotational grazing should be practised so that the pasture is not subject to overgrazing as this will result in its degeneration to inferior grasses and weeds. On the other hand, undergrazing will give rise to unpalatable herbage of high fibre content and to severe leech infestation in areas where this pest occurs. Stock do not readily graze on such pastures. But if well managed, pastures can be of great value in Ceylon. There is not much land available for pasture in the wet lowland zone, except under coconuts and here is the opportunity for coconut estate owners to adopt a system of raising good cattle with coconuts through pastures which will not only provide the feed for their cattle but will also improve the production of nuts.

Salvinia in Ceylon*

BY

J. E. SENARATNA

1.—INTRODUCTION

THE water fern known as *Salvinia* was introduced from Bengal and accidently escaped into the waterways around Colombo where it spread with remarkable rapidity. When a plant is introduced into a new country it may not be in equilibrium with its new environment, its natural competitors may be absent, and if the new environmental conditions prove favourable, in the absence of its natural checking influences, the plant may spread to such an extent as to overrun its newly found home. In this manner, *Salvinia* has assumed serious proportions in Ceylon while it is not considered such a problem in its native lands.

2.—DISTRIBUTION IN CEYLON

Two species of *Salvinia* appear to have been accidentally introduced into the waterways at Colombo before 1940 : *S. auriculata* Aubl., native of Tropical America; and *S. natans* Hoffm., native of Bengal to North China, and Southern Europe. It is significantly the former species which has now spread so widely in Ceylon. On account of its rapid method of increase, the fern had by 1943 overrun the waterways along the sea coast from Negombo as far south as the Bolgoda Lake. At present, it covers most of the waterways along the coast from Puttalam in the North, through the North-Western, Western, and Southern Provinces as far as Matara and inland as far as Kurunegala. It has appeared recently further inland, in the Matale District, in the Ratnapura District, and even on the Eastern coast, in the Batticaloa District. There is little doubt that it occurs in isolated patches elsewhere.

3.—DESCRIPTION

Salvinia is a free-floating water fern with two different-looking forms :— the juvenile form with small aerial leaves lying flat on the surface of the water ; the leaves increase in size and the plant ultimately assumes the adult form bearing more or less upright crowded aerial leaves and reproductory bead-like structures (termed sporocarps) which develop as a chain of 4 to 50 beads hanging down in the water.

*See also Senaratna, *Salvinia auriculata* Aublet, in this Journal Vol. XCIX, 1943, pages 146–149 with map, and plates 1 3 (after page 270). The present note, likewise, refers to *S. auriculata* Aubl. unless specifically stated otherwise.

4.—PROPAGATION

The plant gives off numerous offsets or branches which readily break away from the parent to start as new individuals. The stem, too, may break up to form separate entities. Vegetative reproduction is so prolific that in a few months, large stretches of water can be entirely covered by the plant.

In addition, reproduction by spores formed within the sporocarps which may be produced throughout the year is possible although this method has not been observed so far. This article deals specifically with *S. auriculata.* Sporocarps have not been observed on *S. natans* which resembles the juvenile form of the former.

5.—DISPERSAL

The methods by which this plant reaches new localities are several. Winds blow it to new areas on the same stretch of water. Tides and floods disperse it to new areas. Waterbirds carry juvenile plants sticking to their feet or other parts of the body to distant localities. Buffaloes transport it to nearby fields and waters. Other animals may likewise spread it. Man unwittingly helps its dispersal by growing it in ponds for ornament and in aquaria. As the plant increases very rapidly by vegetative means, new infestations appear suddenly.

6.—ECONOMIC SIGNIFICANCE

This rapid growth gives rise to a dense carpet-like cover on the water surface. The growth may be so thick that paddy plants are prevented from coming through. It may form floating islands of a solid mass of the decayed plants and collected silt and debris on which grasses and other plants grow. It silts waterways and irrigation channels. It is probable that it helps the spread of filariasis which affects human beings. It has become a serious nuisance at the Stanley Power Station at Kolonnawa by choking the water inlet for cooling machinery and it may become objectionable elsewhere. Where there is much overhanging vegetation of the brush-wood type on the banks of water courses where this weed occurs, removal is difficult as fragments of plants which nestle between the vegetation cannot readily be seen, and such fragments can mutliply so rapidly as to cover a large area in a few months' time. A possible use is as a source of organic manure, either fresh or after heaping it to dry.

7.—CONTROL

Methods of control with weedicides are under investigation. The hormone type of weedicide appears most promising. Trials are in progress to determine the most economical type of weedicide and concentration to be used. A careful watch is necessary to prevent the weed being introduced to new areas. Wherever possible, the plants should be removed by hand collection. Spread of the plant in large infestations should be prevented by laying planks or bamboos across the water and collecting the mass of plants at the bamboo barrage or boom.

Weed Control in Paddy

(PUBLISHED AS A DEPARTMENTAL LEAFLET)

WEEDS rob the paddy plant of the light, air, water and food that would have gone to increase the yield of grain. Moreover, weeds harbour insects and fungi harmful to paddy, and the suppression of weeds reduces disease and pest hazards. The low standard of weed control is one of the main causes of poor yields in many parts of Ceylon.

Most cultivation practices, e.g., preparatory tillage, impounding water, harrowing the growing paddy and transplanting, may be interpreted largely as measures of weed suppression, and an increase in the efficiency of these practices would contribute to better weed control.

WEED SPECIES

The difficulty of controlling a species of weed appear to depend on the degree of its relationship to rice. Wild rices (*S. Uruwi* ; *T. Pandinel*) which fall within the limits of the same genus as cultivated rice, and of which there are three species native to Ceylon, are particularly pernicious. They cross freely with cultivated rice and may seriously contaminate seed stocks. Wild rices shed readily and transmit this undesirable character, among others, to their hybrid progeny. Fortunately, wild rices are not extensive except in the Eastern Province.

Weeds of the grass family, to which paddy also belongs, present almost as difficult a problem. Erect tufted grasses like *maruk* (*Echinochloa* spp.), *kirindi* (*Coix gigantea*) and *gojerawalu* (*Ischaemum rugosum*) are practically indistinguishable from paddy till they flower. These grasses are, moreover, alternate hosts of the paddy bug.

Kirindi is troublesome in tracts that grow a single long-duration crop a year. Such tracts occur in the Kurunegala and Kegalle Districts. When an early variety is grown in *yala*, the *kirindi* germinates and grows but is cut along with the paddy before it can mature and set its seed. Seeds commence sprouting about four days after the paddy is sown. The weed flowers in five months along with the paddy, and is at that time, difficult to uproot without considerable damage to the paddy. The growing of paddy in both *yala* and *maha*, or the substitution of a 3–4 months variety in the *maha* season reduces the severity of the infestation. Fields that cannot be cropped in *yala* may be placed under vegetables in that season ; *kirindi* seeds sprout under cultivation and can be removed. The vigorous root system makes the removal of the

weed difficult unless it is done early ; plants often snap leaving a root stock which ratoons. The seeds are protected by a stony coat, possess great longevity and may survive in the soil for long periods. Burning the paddy stubble promotes germination of *kirindi* seed. Submerged seeds do not germinate, and fields should accordingly be flooded as soon as the growth of the paddy permits it. Not only would sprouting be largely suppressed, but sprouted seedlings would die.

Four species of *maruk* have been recognised in this country. Brief descriptions of these species are given below :—

Species of maruk	*Habit*	*Awns*	*Earheads*
1. *Echinochloa colona*	annual	absent	open
2. *Echinochloa frumentacea*	annual	absent	closed
3. *Echinochloa crus-galli*	annual	long	closed
4. *Echinochloa stagnina*	perennial	short	open

All four species occur in both the dry and the wet zones. *E. stagnina* is the commonest and the most troublesome. *E. colona* and *E. crus-galli* are less widespread than the other two species. All the species produce numerous seeds which are shed on the ground ; *E. stagnina* produces over a thousand seeds per plant. The seeds germinate when the land is tilled and flower in about six weeks. Unless a very early variety is grown, the *maruk* flowers before the paddy, and the earheads which often obstrude above the level of the crop can be slashed before they mature. Seed paddy from *maruk*-infested fields can be cleaned by immersion in water ; unfilled grain and *maruk* seeds rise to the surface and can be floated off.

Batadella is a prostrate grass which thrives when the supply of water fails to submerge the weed, but permits continuous moistening of the soil. As may be expected, it is particularly troublesome in the wet zone. The grass propagates itself both vegetatively and by seed. Leaving land fallow in *yala* aggravates the infestation. If the rainfall does not permit the growing of paddy in *yala*, vegetables or some other high land crop should be raised.

The sedges, *kudamatta* (*Fimbristylis miliacea*), thunase (*Cyperus iria*) and *thunhiriya* (*Cyperus dehiscens*) are widespread. Their prodigious rate of multiplication is partly due to the profusion of seeds and partly to their short life cycle ; a *kudamatta* plant produce over 8,000 seeds per plant, and a *thunase* plant nearly 3,000 seeds. The seedlings appear soon after the paddy is sown, flower in about a month, shed their seed and establish a second generation in the same season.

Diyasiyambala (*Aeschynomone indica*) is a leguminous weed that is easily recognised and removed. Numerous other weed species occur, but are rarely as troublesome as the ones listed above.

PREPARATORY TILLAGE

Weeds are rarely troublesome when preparatory cultivation is satisfactorily done. Degree of control over irrigation water, drainage conditions of the land and the availability of men and implements are some of the factors affecting the standard of cultivation and, in consequence, the efficiency of weed suppression. In the wet zone, cropping in both seasons reduces weed infestation, but the choice of variety age-classes should be such as would permit sufficiently long intervals for preparatory tillage. One of the incidental virtues of transplanting is the long period afforded the cultivator for preparatory tillage.

(A) *Under Conditions of Controlled Irrigation.*—Where the impounding of water is under complete control, effective weed suppression is possible. Fields should be ploughed, and sufficient water impounded to cover the soil. Submergence for 2–3 weeks effects satisfactory decay of weeds. At the end of this period, puddle and roughly level the soil with a wooden tooth harrow. Levelling should be continued with the beam of the wooden harrow (with the teeth removed), and completed with a hand levelling board (*S. Athporuwa*). The efficient use of irrigation water in weed suppression is possible only if fields are correctly levelled. Sprouted seed is then sown. After 3–4 days, commence letting in water, and as the plants grow, progressively raise the level of water to an eventual depth of about six inches. In the early stages of the growth of paddy, a 5–7 day interval of complete drying of the fields contributes both to weed control and to the vigour of the crop. This interval apart, sufficient water should be maintained till the field is drained previous to ripening of the crop.

(B) *Under Rainfed Conditions.*—In areas where rains are late, unsprouted seed is sown on dry soil (*S. Kekulan*). The fields should be ploughed with a mould-board plough (Model C or D), and harrowed just before sowing.

Where rains are early, water is collected within ridged fields, and is not released till preparatoy tillage is completed. Other operations are as described under (A).

WEED CONTROL IN THE GROWING CROP

Correct levelling will permit covering of the entire soil surface in a *liyadda* without submergence of the paddy plants. Standing water in the fields prevents weed growth.

If weeds are established as a result of the lack of water, further growth can be checked by impounding water as soon as it becomes available. The level of water should be sufficiently high to submerge the weeds but not the paddy.

If weeds have grown to the same height as the paddy, a hand levelling board or the beam of a wooden harrow (with the teeth removed) drawn across the field with sufficient standing water, will press down both the weeds and the paddy. The paddy plants erect themselves in a few days. The weeds remain under and die. The method is particularly effective in the suppression of *kudamatta*.

Harrowing the Growing Crop.—A broadcast crop may be profitably harrowed when it is 3–4 weeks old. Besides checking weeds, harrowing thins the crop.

The technique of harrowing is as follows :—

(1) Drain the fields leaving about three inches of water.

(2) On the following day, draw a wooden tooth-tooth harrow by buffaloes, across the crop. Except where the land is swampy, weight the harrow by riding on it. At intervals, lift the harrow and clean the tines.

(3) A few hours after harrowing or on the next day, lower the levels of water till it barely covers the soil. In areas where the water supply is precarious, however, water should not be reduced.

(4) Women should follow the harrow, thinning dense patches filling vacancies and weeding lightly.

(5) The maintenance, for about a week of sufficient water to cover the soil, is necessary for the recovery of the harrowed crop. Normal irrigation is subsequently resumed.

Hand Weeding.—This is arduous and expensive, but should be done, if satisfactory weed suppression by the methods mentioned above has not been possible. Weeding should commence about three weeks from sowing and should be completed in 7–10 days before tillering begins. Weeds should be uprooted before they bloom and set seed. If the uprooted weeds cannot be conveniently trampled in, they may be stacked on ridges.

Hand weeding, even if it is not completely eliminated, is made easier by transplanting. Transplanting has, of course, numerous other virtues and should be adopted wherever it can be profitably practised.

RESEARCH NOTES

Late Blight of Potato

POTATOES grown during the last four or five years at various upcountry farms have been consistently attacked by the disease known as "late blight" caused by the fungus *Phytophthora infestans*. Repeated attacks have reduced yields and led to a general decrease in tuber size. This disease, whose ravages are increased by wet weather during the latter period of the growth of the crop (hence the term late blight), is the most important disease of potato known and is present wherever this crop is grown. An experiment was carried out last Maha at Rahangalla potato farm and excellent control of the disease has been obtained by routine spraying of the crop with copper fungicides. Three fungicides were used: Perenox, Cupravit, and Bordeaux mixture sprayed weekly and fortnightly. With all the three fungicides, weekly spraying was better than fortnightly sprayings. There was no significant difference between the three fungicides. Weekly-sprayed plots gave an increase of 80 per cent. yield over the unsprayed controls. Calculated on an acre basis, the profit due to spraying after paying the costs of spraying was Rs. 1,668 per acre. A more detailed account of this experiment will follow shortly.

J. W. L. Peiris.

A Note on a Method of Transplanting

THE establishment of transplanted seedlings necessitates the presence of sufficient moisture in the soil especially in the root region of the seedling. In practice it is not always possible to do the transplanting when optimum conditions obtain, and it is therefore necessary to hand-water the seedlings to enable them to establish themselves. This problem was examined with a view to cutting down the cost of the operation, and a satisfactory technique has been worked out which achieves this object.

It was noticed that when rainfall occurs in scanty showers, the soil dries out rapidly on the surface but remains moist down to 3 to 4 inches below. A seedling planted with its roots in this moist region will find no difficulty in establishing itself. This could be done with a mechanical transplanter but, in the absence of such a machine, one has the alternative of either holing and planting out or of planting the seedlings in furrows. The former alternative is only practicable on small areas where a hand trowel or mammoty is used for holing. On a slightly larger scale the method is very costly. The latter method, i.e., of planting seedlings in furrows has been tried out and found to be successful and cheap.

Furrows are turned up with a plough at the required inter-row distance. No marking is necessary, if trained bullocks and ploughmen are used, and the yoke length so adjusted to lay down the furrows the required distance apart. It is not necessary to work the plough

a second time in the opposite direction. The land will then be laid out into a series of evenly spaced furrows, the interspaces being alternately ridges and flats. Seedlings are uprooted from the nursery in the usual way and placed in the furrow at the required spacing and covered with a little soil from the adjacent ridge ; only sufficient soil to cover the roots is used, and firmed down round the plant. The flat interspaces are cultivated. Four weeks after transplanting, the final dose of fertilizer is applied and the ridged interspaces are cultivated. This latter cultivation covers the furrows and gives the plants a little earthing-up as well.

This method is quick and economic in labour under most conditions and is of special advantage when soil moisture is the limiting factor.

K. N. Jeyaseelan.

The Citrus Karna as a Root-stock for Some Citrus Species in the Wet Zone

THIS species is popularly known as Karna Lemon. Bonavia called it *Citrus Aurantium* var. " Khatta " but Rafin, A. F. recognized it as a distinct species and called it " *Citrus Karna* ".

The seedlings are more vigorous and reach budding stage much earlier than the rough lemon (*C. Jambhiri*), the standard root-stock. Its root system, though not so extensive as the rough lemon, possesses a longer tap root with sturdy lateral roots distributed mostly at its base.

Karna seeds were obtained from Bombay for root-stock experiments at the School of Agriculture, Peradeniya. Seedling trees that remained submerged for a number of days during the last floods did not suffer adversely due to water-logging ; but the rough lemons were unable to survive this condition. The *C. Karna* is superior to the rough lemon in its bearing habits. Trees bear early and are prolific and consistent in bearing.

The Karna Lemon is botanically very distinct. In the character of its foliage and flower, it resembles the lemon ; and in its fruit, the citron. Its characters are constant and no variation has been noticed though raised from the seed. Budding trials revealed a higher percentage of " bud take " on it than on the rough lemon with various scions, particularly limes. The Tahiti seedless lime showed an early " bud take ", vigorous growth, and a tendency to early flowering.

The *C. Karna* appears to be a suitable root-stock from the point of view of its adaptability to soil conditions in the wet zone, its initial vigour of growth, its high percentage of " bud take " and its ability to produce abundant seed material. But definite conclusions cannot, however, be drawn from root-stock experiments until the trees have come into full bearing.

E. P. Buell.

Hormones from the Dung of Pregnant Cows

HITHERTO we have been using Stilbesterol to induce oestrus in cows. This drug is, however, costly. With the view to cutting down the cost of this treatment it was decided to search for a cheaper source of similar hormone.

Bhaduri, in an attempt to develop pregnancy test, has found that dung of pregnant cows contains a hormone which when injected into a male toad produced spermatogenesis in one hour.

At the Artificial Insemination Section of the laboratory we have prepared an extract from the dung of a pregnant cow and carried out tentative experiments with it. Four cows were given the extract intramuscularly in doses of 20 cc. Oestrus was noticed in two within four days of administration. Further tests of this product will be carried out in the field.

P. JEGANATHAN.

Selections

THE issue by the A. R. OO. and the Botanist and Senior A. R. O. of the paddy selections listed below is announced :—

Selection	*Remarks*	*Recommended for trial by D. A. OO*
1. Heenati 309 ..	*yala* selections, *86 days* from sowing to harvest, superior to Pachchaiperumal 2462/11	In the dry zone, in *yala*
2. Heenati 310 ..		
3. Murunga 307 ..	*yala* selections, *3 months* from sowing to harvest, superior to Pachchaiperumal 2462/11	
4. Murunga 308 ..		
5. Suduwi 305 ..		
6. Suduwi 306 ..		
7. Wanni Dahanala 101	A *yala* selection, *3 months* from sowing to harvest	
8. Suali .. 301 ..	A *maha* selection, *4 months* from sowing to harvest, superior to Vellai Hankalayan 28061	In the dry zone in *maha*, sown broadcast
9. Dikwi .. 302 .. Broad grain	*maha* selections, *4 months* sowing to harvest, superior to Vellai Hankalayan 28061	In the dry zone in *maha*, transplanted
10. Dikwi .. 303 .. Medium grain		
11. Dikwi .. 304 .. Narrow grain		
*12. M—24	High-yielding, resistant to lodging and grain-shedding, *4½ months* from sowing to harvest	In the Ratnapura District, in *maha*
*13. R—27	High-yielding, resistant to lodging and grain-shedding, *5 months* from sowing to harvest	
*14. S—29	High-yielding, resistant to lodging and grain-shedding, *5½ months* from sowing to harvest	
*15. T—27	High-yielding, resistant to lodging and grain-shedding, *5 months* from sowing to harvest	In the Kurunegala District, in *maha*

* Introduced from Indonesia and Malaya.

NOTIFICATIONS

The Plant Protection Ordinance

Notification

IT is hereby notified that the Minister of Agriculture and Food, in pursuance of the powers vested in him by regulation 5 of Part II of the Regulations set out in the Schedule to the Plant Protection Ordinance (Chap. 307), as modified by the Proclamation published in *Gazette Extraordinary* No. 9,773 of September 24, 1947, has declared the plant known as *Salvinia cucullata* or the water fern to be a " weed " to which the regulations in Part II aforesaid shall apply.

K. SOMASUNTHARAM,
Permanent Secretary,
Colombo, September 3, 1952. Ministry of Agriculture and Food.

(Extract from the " Ceylon Government Gazette " No. 10,447, of September 12, 1952.)

" The Plant Protection Ordinance, No. 10 of 1924

IT is hereby notified under regulation 12 of Part II of the Regulations set forth in the Schedule to the Plant Protection Ordinance, No. 10 of 1924, that the treatment specified in the Schedule hereto is prescribed for the treatment of the weed *Salvinia cucullata* or the water fern.

A. W. R. JOACHIM,
Peradeniya, September 6, 1952. Director of Agriculture.

SCHEDULE

All Salvinia plants must be removed from any place where they are growing in water and should be destroyed, by heaping on high ground exposed to the sun to rot and decay, or by burying."

(Extract from the " Ceylon Government Gazette " No. 10,447 of September 12, 1952.)

The Plant Protection Ordinance (Chapter 307)

Notice

BY virtue of the powers vested in me by regulation 12 of the regulations set out in the Schedule to the Plant Protection Ordinance, No. 10 of 1924, I prescribe that the leaf-disease of rubber trees (*Hevea brasiliensis*) caused by the fungus *Oidium heveae* Stein, shall be treated in the manner set out hereunder—

(1) All rubber trees growing in Ceylon shall be annually dusted with dusting sulphur.

(2) Nothing in the provisions of paragraph (1) shall apply or be deemed to apply to—

(*a*) rubber trees growing in any plantation or garden which is less than 50 acres in extent ; or

(*b*) rubber trees growing at an altitude of 1,000 ft. or more above mean sea level ; or

(*c*) rubber trees which are less than six years of age ;

(*d*) rubber trees growing in any estate, or part of an estate, where the average yield of rubber per acre does not exceed 500 lb. per annum.

(3) The dusting in each area or field of the plantation shall commence before 50 per centum of the trees in that area or field have defoliated. The dusting shall thereafter be carried out at seven-day intervals until at least five applications have been made in the case of monoclonal rubber and at least eight applications in the case of seedling rubber.

(4) The standard dosage of dusting sulphur to be used for dusting shall be 12 lb. for an acre for each application.

(5) The sulphur to be used for dusting shall be free-flowing dusting sulphur powder which conforms to the following specifications :—

(*a*) at least 90 per centum of the powder must be capable of passing through a 300-mesh standard sieve ;

(*b*) the powder must contain at least 85 per centum of pure sulphur by weight.

(6) If the sulphur powder used for dusting does not conform to specification (*a*) or specification (*b*) of paragraph (5), the standard dosage shall be calculated as follows :—

(*a*) In the case of sulphur powder which does not conform to the specification (*a*) in paragraph (5), the standard dosage shall be—

$90/Q \times 12$ lb. for an acre for each application where Q is the percentage of the powder which passes through a 300-mesh standard sieve.

(*b*) In the case of sulphur powder which does not conform to specification (*b*) in paragraph (5), the standard dosage shall be—

$85/R \times 12$ lb. for an acre for each application where R is the percentage of pure sulphur by weight in the powder.

(7) The sulphur dusting shall be carried out by a dusting appliance approved by me.

(8) Other methods of controlling the disease caused by the fungus *Oidium heveae*, may be carried on with my written approval.

September 17, 1952.

A. W. R. Joachim,
Director of Agriculture.

(Extract from the "Ceylon Government Gazette Extraordinary" No. 10,448 of Wednesday, September 17, 1952.)

REVIEWS

The Useful and Ornamental Plants of Trinidad and Tobago (Revised Fourth Edition)

BY

R. O. WILLIAMS and R. O. WILLIAMS (Jnr.)

Guardian Commercial Printery, Port-of-Spain, Trinidad, B.W.I., 1951, 335 pp., $ 2

THE revised fourth edition has brought this useful publication up to date and the authors are to be congratulated on making such a success of it in spite of its having been prepared in Zanzibar, far away from Trinidad. It is unfortunate that the hope to include illustrations had to be sacrificed in order to meet popular demand for a cheaper book. The cheapness should make a larger public use it than would otherwise have been possible. It is hoped, however, that illustrations will be included in a future edition.

The original edition of this book was under the authorship of W. G. Freeman and R. O. Williams, and published in 1927. It must have been deservedly popular, meeting a long-felt need, for a second revised edition to have been published the next year (1928). Its object, as stated in the preface to the second edition, was to give general information about the plants, whether native or introduced, of interest in Trinidad and Tobago, for their useful and ornamental qualities. Such information lying scattered in numerous publications has been brought together in a form with appeal to a wide public.

The lists of plants under various headings such as " Major Plantation Crops ", " Fodder Crops and Grasses ", " Medicinal Drugs and Narcotics ", under which the botanical name, common name, and uses are tabulated, are a commendable feature. These lists at the beginning of the book show at a glance the subject-matter in summary, and detailed information may be obtained by reference to the botanical name to which also cross-reference is given against the common name. While in the main the arrangement is alphabetical and detailed information is given under each botanical name, plants belonging to certain groups such as Orchids, Ferns, and Grasses, are treated under the group heading. Taking for example Grasses, the information is given under the sub-divisions (I) Grasses, Fodder, (II) Grasses for Lawns, and (III) Grasses, Pasture.

The addition of keys in simple language referring to easily observable diagnostic characters is very helpful in identification of the plants and is a much desired feature, though usually lacking in similar works. The help of several authorities has been secured for their special subjects, as for example Prof. E. E. Cheesman for the notes on *Musa*, and this enhances the value of the work. The cultural notes at the end of the book are given mainly to assist local gardeners and particularly those who are anxious to grow more food for home consumption.

Most of the world's wealth of useful and ornamental plants suited to a particular climatic region have been successfully introduced to practically every country with a similar climate, and many of the plants dealt with in the book are familiar to the people of Ceylon as well as to those of other tropical countries. To such people, interested in useful and ornamental plants, whether as professional planters, foresters, and horticulturists, or as amateur gardeners and vegetable growers, this handbook will be a useful addition to the available literature.

Peradeniya, August 28, 1952. J. E. SENARATNA.

4—J. N. B 31690 (10/52)

MEETINGS, &c.

Rubber Research Institute of Ceylon

MINUTES OF THE 114th MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEAD-QUARTERS, COLOMBO, AT 2.30 P.M. ON THURSDAY, JULY 31, 1952

Present.—Mr. W. A. Paterson, J.P. (in the Chair), Dr. H. E. Young (Director), Mr. W. P. H. Dias, J.P., Mr. W. Herbert de Silva, Major Montague Jayawickrema, M.P., Gate Muhandiram Arthur D. S. Jayasinghe, Dr. A. W. R. Joachim (Director of Agriculture), and Mr. F. A. Ruck.

Senator C. F. W. Wickremesinghe had expressed his inability to attend.

1. BOARD

The Chairman welcomed to the Board—

(*a*) Major Montague Jayawickrema, M.P., who had been re-nominated by the Hon. the Minister of Agriculture and Food to represent the House of Representatives for a period of three years with effect from July 21, 1952.

(*b*) Senator C. F. W. Wickremesinghe, who had been nominated by the Hon. the Minister of Agriculture and Food to represent the Senate for a period of three years with effect from July 21, 1952.

2. MINUTES

(*a*) *Confirmation.*

Draft Minutes of the meeting held on May 19, 1952, which had been circulated to members, were approved and signed by the Chairman as correct.

(*b*) *Matters arising from the minutes :*

Visiting Engineer's Report—Extra 25 K.W. Generator.—Quotations for the supply of a 25 K.W. Generator set were considered and purchase approved.

3. REPORTS AND ACCOUNTS

(*a*) *Director's and Technical Officers' Reports for the 1st half-year 1952.*—These were approved and it was agreed that future reports should be for half-yearly rather than quarterly periods.

(*b*) Estate Accounts from January to March, 1952, were tabled.

(*c*) *Investments.*—Withdrawal of a fixed deposit and investment of the amount in Ceylon Government 3 per cent. Loan 1973–78 was reported and approved.

(*d*) *Supplementary votes.*—Supplementary votes amounting to Rs. 30,530 were passed to cover the cost of the following items :—

1. Two portable Aerogen gas machines.
2. Store for sulphur and dusting machines.
3. Portable gantry for factory.
4. Extension to Estate Superintendent's bungalow.
5. Sulphur-dusting equipment.

4. STAFF

(*a*) *Director.*—It was reported that Dr. H. E. Young, Director, had returned from leave and resumed duties on June 26, 1952. He had gone with Dr. Risdon, Chemist, to attend the Conference of Scientific Officers of Rubber Research Institutes at Bogor, Indonesia, on July 10, and returned on July 29.

It was noted that a report on the visit would be issued to members shortly.

(*b*) *Re-engagement of three Assistant Propaganda Officers.*—Agreed that Messrs. N. W. Palihawadana, H. H. Peiris and K. Wilson de Silva, Assistant Propaganda Officers of the Smallholdings Department, be re-engaged for further periods of four years each, on termination of their contracts in September and October, 1952.

5. INSPECTION OF RUBBER LANDS BY RUBBER INSTRUCTORS

Approval was given for the inspection of rubber lands by Rubber Instructors of the Smallholdings Department in connection with applications to the Rubber Controller for replanting under the Rubber Rehabilitation Loan Scheme.

6. TECHNICAL MATTERS

(*a*) *Export of rubber seeds and plants to Pakistan.*—In response to a request from the Trade Commissioner for Pakistan in Ceylon, it was agreed that a small quantity of rubber seed and budded plants be supplied for export to Pakistan for experimental purposes.

(*b*) *Analysis of Sulphur Samples.*—Agreed that the analysis of sulphur samples, which at present takes up such a large portion of the Mycologist's time, need not be undertaken by him in future as it can be done by a commercial firm of analysts when the required specification is made known.

7. LONDON ADVISORY COMMITTEE

(*a*) *Annual Report for 1951.*—Was tabled.

(*b*) Minutes of the 3rd meeting of the Executive Committee, 2nd meeting of the Latex Sub-Committee, and 1st meeting of the Agricultural Sub-Committee were tabled.

The meeting then terminated.

C. D. DE FONSEKA,
Secretary-Accountant.

Dartonfield,
Agalawatta, August 15, 1952.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT 2-30 P.M. ON FRIDAY, JULY 18, 1952, AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON, THE LAWN, 113, STEUART PLACE, COLPETTY, COLOMBO

Present.—Mr. H. S. Hurst (Acting Chairman), Mr. W. R. Vander Kiste (Chairman, Planters' Association of Ceylon), Mr. W. H. Gourley (Chairman, Agency Section, Planters' Association of Ceylon), Messrs. G. K. Newton, A. J. Dickson, G. J. Harris, L. F. J. Smith, W. Neal de Alwis, J.P., U.M., M.P., Errol Jayawickreme, D. E. Hettiarachchi, J.P., U.M., V. G. W. Ratnayake, M.P., M.B.E., and J. Lamb (Director and Secretary to the Board).

1. NOTICE CONVENING THE MEETING WAS READ

A letter from Dr. A. W. R. Joachim, M.B.E. (Director of Agriculture) and a message from Mr. A. G. Ranasinha, C.M.G., C.B.E., C.C.S. (Secretary to the Treasury), regretting inability to be present were tabled.

2. MEMBERSHIP OF THE BOARD AND COMMITTEES

(*a*) *Board.*

The Chairman reported the following changes in the personnel of the Board which had taken place since the last meeting.

(i) Mr. R. C. Scott, C.B.E., had proceeded on furlough on May 5, 1952. In response to Circular No. A 7/52 of April 4, 1952, Mr. Hurst was unanimously elected to act as Chairman during Mr. Scott's absence. Members had been informed of the decision by Circular A. 8/52 of April 23, 1952, Mr. Scott was expected back in Ceylon in November.

(ii) Mr. W. H. Attfield had resigned his seat on the Board with effect from March 4, 1952, prior to proceeding on furlough. Mr. G. Harris of Messrs. Whittall & Co. had been nominated by the P. A. Agency Section to take his place.

(iii) Mr. A. D. McLeod had proceeded on furlough and Mr. L. F. J. Smith of Messrs. Colombo Commercial Co. had been nominated by the P. A. Agency Section to act for him with effect from April 24, 1952.

(iv) Mr. W. R. Vander Kiste on his election as Chairman of the Planters' Association of Ceylon replaced Mr. R. C. L. Notley as an ex-officio member as from March 28, 1952.

(v) Mr. H. de T. Wilkinson Kay's term of office had expired on June 30, 1952. Mr. A. J. Dickson of Passara Group, Passara, had been nominated by the Planters' Association of Ceylon to fill the vacancy as from July 1, 1952.

The Chairman thanked all outgoing members for the services rendered to the Institute as members of the Board. He made special mention of Messrs. W. H. Attfield and R. C. L. Notley.

He extended a cordial welcome to the new members, all of whom were present at the meeting.

The Secretary was asked to convey to the outgoing members the thanks of the Board.

(*b*) *Finance Sub-Committee.*

The Chairman reported that two vacancies required filling, i.e. those created by the departure of Messrs. R. C. Scott and W. H. Attfield. He proposed that Mr. Errol Jayawickreme be elected to act for Mr. Scott and Mr. W. H. Gourley take the place vacated by Mr. Attfield. Agreed.

(*c*) *Estate and Experimental Sub-Committee.*

The Chairman pointed out that as Mr. Newton was the Visiting Agent for St. Coombs Estate a seat was vacant on this Committee. He referred to Mr. Newton's most comprehensive and interesting report on his first visit to the estate on April 5 and 6, 1952.

He further stated that the Uva and Low-Country districts were not represented on the Committee and proposed that Messrs. R. J. S. Bean, A. J. Dickson and D. E. Hettiaratchchi be nominated to fill those places. Agreed.

3. FINANCE

(*a*) *Accounts for period ending April 30, 1952.*

The Chairman informed the meeting that the Audited Accounts for 1951, and the Auditor's Report thereon had not been received. They would therefore come up for consideration at the next meeting of the Board.

Copies of the accounts of the Institute for period ending April 30, 1952, had been issued to members. Those accounts might be subject to slight alterations on receipt of the audited accounts.

He said that members would note with pleasure that the St. Coombs Estate Working Account had shown a Profit of Rs. 3,871·21 at as early a stage in the year as April. That had been brought about chiefly as a result of the exceedingly favourable cropping weather experienced at St. Coombs during the period January to April and also to the fair market prices realized on our teas.

Crop to end June, 1952, had totalled 153,402 lb., an average of 25,580 lb. per month. The yield per acre at end of June was 156 lb. ahead of last year. If favourable conditions persisted, it was most likely that the estate would end up the year in as favourable a position as in 1951.

Cess collections to and April had also been most favourable and had totalled Rs. 263,418·40 as against Rs. 230,818·84 to same date last year. It would interest members to know that the total cess to end June, 1952 was Rs. 425,345·67 as against Rs. 387,191·67 in 1951 and a total estimate for 1952 of Rs. 735,000.

(*b*) *Investments.*

(i) *T. R. I.*—The Chairman reported that an application had been made for re-investment in the 3 per cent. Ceylon Government Loan of the sum of Rs. 15,000 obtained from the 3 per cent. Defence Loan which had matured on February 23, 1952.

(ii) *Junior Staff Provident Fund.*—The Chairman reported that the following investments had been made on behalf of the above Fund as decided at the previous meeting of the Board.

Rs. 17,000 in 5 years savings certificates (maximum holding).

Rs. 8,000 in 12 years savings certificates (maximum holding).

An application had also been made for the investment of the further sum of Rs. 25,000 in the 3 per cent. Ceylon Government Loan in accordance with the previous decision of the Board.

There would be a total of Rs. 184,649·65 invested on behalf of the Fund when the above investment was made.

(iii) *Junior Staff Medical Fund.*

The Chairman reported that the sum of Rs. 6,000 had also been invested in 5 years saving certificates on behalf of the above Fund as decided at the last meeting of the Board.

4. STAFF

(*a*) *Director.*

The Chairman reported that Mr. J. Lamb, Director, returned from the United Kingdom on the completion of his home leave on May 21, 1952. He had on his way home paid a visit to the Tea Research Institute of Kenya, visited a number of tea plantations in Kenya and Ugenda and attended the formal opening of that Institute on March 27, 1952. A lecture on his visit to East Africa was now being delivered to the various District Planters' Associations.

(*b*) *Plant Physiologist.*

The Chairman reported that Mr. G. B. Portsmouth had proceeded on eight months' home leave on May 20, 1952.

(c) *Pathologist.*

(i) The Chairman reported that Mr. C. A. Loos sailed for the United Kingdom on April 25, to begin his course of 6 months training at Rothamsted Experimental Station. He had already settled down to his task very well judging from reports received.

(ii) The Chairman informed members that the F. A. O. has decided to postpone Mr. Loos's Scholarship in the United States. The matter would be taken up again early in 1953.

(iii) *Visit to Sandoz, Switzerland.*

The Chairman stated that Mr. Loos had received an invitation from the Directors of Sandoz, Ltd., Switzerland, to visit them as their guest for a period of 3 days.

(d) *Agricultural Chemist.*

The Chairman reported that Dr. F. Haworth who had assumed duties as Agricultural Chemist on August 4, 1950, had sent in his resignation and had asked to be released by the end of the year.

He considered it essential to have the post advertised as quickly as possible. The Director had therefore with the unanimous approval of the Appointments Sub-Committee arranged for the post to be advertised in " Nature " and also sent copy of the advertisement to the Registrar of the Royal Institute of Chemistry for publication in their appointments register. The advertisement had also been forwarded to the " Times " (London) as suggested by the Registrar of the Royal Institute of Chemistry.

(e) *Proposed visit by Dr. Dawson.*

The Chairman reported that Dr. Dowson, Reader in Plant Pathology at Cambridge University, who had agreed to visit the Institute for two to three months to advise on the programme of research in Pathology had postponed his visit until after Mr. Loos's return from the United Kingdom.

(f) *Assistant Secretary/Librarian.*

The Chairman reported that Mr. G. Mason had completed six months service and the Director had recommended the confirmation of his appointment as Assistant Secretary/ Librarian.

5. SMALL HOLDINGS SERVICE

(a) *Inspection of Small Holdings.*

The Chairman reported that the Director had carried out inspections of small holdings in the Southern Province and Morawak Korale in the company of Mr. Illankoon, the Officer in-Charge.

The Director said he was pleased to record that, from what he had seen, it was evident that Mr. Illankoon had organized his work well and that he found most of the officers very keen on their work. He referred to the difficulty the officer stationed at Morawak Korale was experiencing in finding a suitable house.

Mr. V. G. W. Ratnayake agreed to do what he could to help in this matter.

Mr. G. K. Newton referred to the poor standard of teas from bought leaf factories which were being shipped to London. He was strongly of the opinion that unless small holders were induced to improve the quality of the leaf they produced most bought leaf factories would soon have to go out of production.

The Director suggested that a meeting be arranged to which Messrs. V. G. W. Ratnayake, W. Neal de Alwis and U. S. Unamboowe and the Senior Small Holdings Officer be invited in order to discuss what action should be taken in this matter. The meeting could also discuss the subject of co-operative factories.

(*b*) *Lease of Bungalow at Peradeniya. Signing of Indenture of Lease.*

The Chairman stated that the Indenture of lease embodying the terms and conditions agreed upon at the inaugural meeting of the Small Holdings Sub-Committee held on October 15, 1951, and accepted by the Board on December 21, 1951, had been drawn up. Messrs. Julius & Creasy had scrutinized the document and it had been arranged for Messrs. G. K. Newton and G. J. Harris together with the Director to sign it on behalf of the Board.

As the Institute's seal would be set to the document, the Chairman said that a formal proposal was necessary and he proposed that :—

" Resolved that the execution of the lease in favour of the Institute for a period of three years commencing from the 1st of October, 1951, relating to the bungalow and premises called " Keppelstone " in extent A. 0, R. 1, P. 18, under the seal of the Board in the presence of Mr. G. K. Newton and Mr. G. J. Harris, members of the Board and Mr. James Lamb the Director of the Institute on July 18, 1952, is hereby confirmed."

Approved unanimously.

6. ANY OTHER BUSINESS

Electric Supply.

The Chairman informed members that negotiations had been re-opened with the Government Electrical Department for the linking up of St. Coombs to the Government electric supply. To begin with it was proposed to connect up the factory and the Junior Staff line and later, if funds permitted, to connect up the laboratory and Senior staff lines.

Tea Research Institute,
Talawakelle.

J. LAMB,
Secretary.

RETURNS

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED JUNE 30, 1952

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to June 30, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	14	37	—	—	23	14
	Rabies	1	4	3	1	—	—
Colombo Municipality	Foot-and-mouth	12	190	—	—	178	12
	Rabies	1	26	26	—	—	—
Quarantine Station	Anthrax	—	4	4	—	—	—
	Pleuro-Pneumonia	21	114	114	—	—	—
Northern Province	Anthrax	—	107	107	—	—	—
	Rabies	—	1	—	1	—	—
	Foot-and-Mouth	162	364	2	—	273	89
	Black Quarter	20	137	137	—	—	—
North-Central Province	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Rabies	—	2	—	2	—	—
	Anthrax	—	16	16	—	—	—
Central Province	Mange (cattle)	12	177	9	—	156	12
	Foot-and-mouth	41	470	1	1	429	39
	Rabies	—	2	—	2	—	—
Province of Sabaragamuwa	Foot-and-mouth	—	428	22	—	406	—
	Rabies	—	6	—	6	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva	Rabies	—	3	2	1	—	—
Eastern Province	Foot-and-mouth	233	729	33	—	587	109
Southern Province	—	—	—	—	—	—	—

Department of Agriculture,
Peradeniya, Ceylon,
August 4, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

5—J. N. R 31690 (10/52)

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED JULY 31, 1952

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to July 31, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	61	98	—	—	77	21
	Rabies	1	5	4	1	—	—
Colombo Municipality	Foot-and-mouth	10	200	—	—	190	
	Rabies	3	29	29	—	—	—10
Quarantine Station	Anthrax	—	4	4	—	—	—
	Pleuro-Pneumonia	91	205	205	—	—	—
Northern Province	Foot-and-Mouth	435	799	2	—	632	165
	Anthrax	—	107	107	—	—	—
	Rabies	—	1	—	1	—	—
	Black Quarter	4	141	141	—	—	—
North-Central Province	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Rabies	—	2	—	2	—	—
	Anthrax	—	16	16	—	—	—
Central Province	Mange (cattle)	5	182	11	—	166	5
	Foot-and-mouth	1	471	1	1	468	1
	Rabies	—	2	—	2	—	—
Province of Sabaragamuwa	Foot-and-mouth	—	428	22	—	406	—
	Rabies	—	6	—	6	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva	Rabies	—	3	2	1	—	—
Eastern Province	Foot-and-mouth	—	729	33	—	691	5
	Black Quarter	18	18	18	—	—	—
Southern Province	—	—	—	—	—	—	—

Department of Agriculture,
Peradeniya, Ceylon,
August 26, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, JULY, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	91·5	+0·6	76·2	+0·2	61	86	5·3	1·93	4	+ 0·61
Badulla	86·3	+0·1	63·6	—0·6	62	94	5·1	2·22	6	+ 0·05
Batticaloa	91·8	—0·3	77·0	0	72	86	5·4	2·24	5	+ 1·20
Colombo	84·7	—0·1	77·6	+0·6	79	86	7·0	0·28	2	— 5·21
Diyatalawa	78·3	+0·3	61·9	—0·7	63	81	6·2	4·11	8	+ 2·15
Galle	81·8	—1·0	77·4	+0·7	86	91	5·9	3·68	8	— 2·66
Hambantota	88·3	+0·9	76·7	+0·4	72	88	5·1	0·99	5	— 1·02
Jaffna	86·3	+0·2	79·6	—0·2	79	85	6·3	2·66	4	+ 2·11
Kandy	84·5	+1·7	71·3	+0·7	73	85	6·6	1·13	14	— 6·19
Kankesanturai	89·4	—	79·1	—	70	85	7·2	3·30	4	—
Kurunegala	87·0	+0·7	75·8	+0·6	72	86	6·0	0·82	8	— 3·06
Mannar	86·8	—0·6	78·6	—0·6	81	89	6·9	1·64	3	+ 1·29
Nuwara Eliya	—	—	55·4	—0·6	81	88	7·4	8·10	15	— 2·92
Puttalam	87·1	+1·1	78·0	—0·4	75	86	6·5	0·09	2	— 0·90
Ratmalana	84·1	—	77·6	—	80	86	6·8	0·32	2	— 5·14
Ratnapura	87·0	+0·4	75·1	+0·6	76	93	6·8	3·95	20	— 8·82
Talawakele	71·6	+1·4	59·6	+0·1	84	94	6·6	7·86	21	— 5·44
Trincomalee	92·1	—0·4	77·8	—0·3	61	78	6·3	5·55	6	+ 3·82

WEATHER SUMMARY, JULY, 1952

Weather conditions in July were mainly warm and dry. The only period during which rainfall of any appreciable extent had been experienced was from 6th to 11th, when, owing to a low pressure wave, the weather became unsettled, resulting in cloudy skies, low temperatures and fairly widespread rain with occasional thunder. Many stations, scattered over the Island, recorded daily falls of over 2 inches on one or the other of these days, while Diyatalawa experienced a hailstorm on the 7th. After these unsettled conditions passed away the weather became unusually dry and remained so till the end of the month. No rain at all was recorded between the 20th and 22nd.

Owing to these dry conditions the rainfall was considerably below normal in the south-west quarter, the region that receives most rain in July. Large deficits, of the order of 10 to 15 inches, occurred in the hill-country, the highest being 16·99 inches at Theydon Bois Group, 14·01 inches at Kenilworth Estate, 13·27 inches at Watawala and 12·99 inches at Kitulgala. In the south-western low-country the deficits ranged from 2 to 5 inches.

Rainfall was above normal in the north and the east and in the lee of the hills, but the excesses were generally small, the only appreciable ones being 6·05 inches at Kehellandewewa, 5·76 inches at Rotawewa and 5·37 inches at Diwulana.

Largest monthly totals occurred in the south-western hill-country, viz., 17·28 inches at Luccombe Estate, 16·65 inches at Norton Bridge, 16·20 inches at Abergeldie Group, 16·07 inches at Watawala, 15·53 inches at Kenilworth Group and 14·96 inches at Blackwater Estate. From this region the rainfall decreased rapidly, the monthly totals in the south-western low-country ranging from 2 to 5 inches only. A majority of stations outside the south-west quarter recorded less than 2 inches for the month.

There were no daily falls over 5 inches in July.

Temperatures were above normal by day and about normal by night. The highest temperatures recorded during July were 97·7° at Kankesanturai on the 8th and 97·3° at Anuradhapura on the 4th, while the lowest temperature for a low-country station was 71.3° at Galle on the 11th, and the lowest for the whole Island 52·1° at Nuwara Eliya on the 5th. Day humidity ranged from 60 to 75 per cent. in the dry zone and from 75 to 85 per cent. in the wet zone. Night humidity ranged generally from 80 to 95 per cent. Cloud amounts were above normal and wind strength about normal, the prevailing direction of wind being south-westerly.

A. P. KANDASAMY,
Acting Director.

METEOROLOGICAL REPORT, AUGUST, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·6	+1·2	76·6	+1·0	57	82	5·4	0	0	— 1·62
Badulla	86·3	+0·2	64·1	—0·3	63	94	6·2	2·19	7	— 1·01
Batticaloa	92·7	+2·3	76·8	+0·3	67	82	5·0	0·10	5	— 1·85
Colombo	86·2	+1·4	77·2	+0·2	79	89	7·2	0·42	5	— 3·61
Diyatalawa	78·6	+0·7	61·1	—0·6	62	84	6·4	1·51	4	— 1·61
Galle	82·2	—0·4	77·1	+0·4	83	89	5·8	3·04	16	— 3·10
Hambantota	88·4	+1·5	76·1	0	74	91	4·0	0·39	4	— 1·05
Jaffna	86·1	+0·1	79·8	+0·5	78	85	5·8	0·20	2	— 0·91
Kandy	81·8	—1·5	70·4	+0·3	79	90	7·0	5·39	22	— 0·34
Kankesanturai	90·6	—	79·4	—	67	82	6·8	0·19	3	—
Kurunegala	85·8	—1·1	75·4	+0·5	73	88	7·0	4·74	20	+ 1·12
Mannar	86·8	—0·6	78·7	+0·1	80	89	6·1	0	0	— 0·66
Nuwara Eliya	65·2	—0·9	55·9	+1·6	86	91	7·6	5·16	24	— 2·35
Puttalam	85·7	—0·7	78·1	+0·2	76	84	6·4	0	0	— 0·65
Ratmalana	85·4	—	78·1	—	76	84	6·7	0·45	5	— 3·03
Ratnapura	86·2	—0·5	74·8	+0·5	78	93	7·1	7·04	28	— 4·35
Talawakele	70·5	—0·6	60·0	+0·8	92	97	7·5	11·10	29	+ 1·02
Trincomalee	94·4	+2·3	78·3	+1·0	57	76	5·6	0·93	5	— 2·68

WEATHER SUMMARY, AUGUST, 1952

South-west monsoon weather prevailed over the Island in August. But the winds were rather dry, except in the south-western hill-country where rainfall was experienced almost every day. Monthly totals in this region exceeded 25 inches, the highest being 42·07 inches at Weweltalawa Estate, 36·70 inches at Norton Bridge, 34·08 inches at Kenilworth Estate, 32·97 inches at Blackwater Estate, 32·65 inches at Watawala and 31·45 inches at Padupola.

From this area there was a rapid decrease in rainfall, monthly totals in the south-western low-country being mainly below 5 inches. Outside the south-west quarter, the rainfall was less than 2 inches, practically no rain being recorded in the North-Central Province, in Puttalam and Mannar Districts and in the neighbourhood of Hambantota.

Owing to these dry conditions, rainfall was below normal throughout the Island, except in the western and south-western hill-country and neighbourhood. The greater deficits (of the order of 2 to 5 inches) occurred in the south-western low-country and in the lee of the hills, the highest being 7·42 inches at Udugama, 5·39 inches at Pimbura and 5·36 inches at Labuduwa.

Drought conditions were felt acutely in the south-western low-country, where rainfall was continuously in deficit during the last 4 months, May to August. Accumulated shortfalls at some stations exceeded 20 inches, e.g., 25·73 inches at Matugama (Sirikandura Estate), 24·90 inches at Neboda (Gikiyanakande Estate), 24·19 inches at Bentota (Kanana Estate) and 21·41 inches at Udugama.

Highest excesses during August occurred in the south-western hill-country, and included 25·99 inches at Weweltalawa Estate, 9·74 inches at Luccombe Estate, 9·65 inches at Blackwater Estate and 9·55 inches at Norton Bridge.

There were 6 daily falls over 5 inches during the month, 5 of them occurring on the 28th, with 6·46 inches at Kanangama Estate as the highest.

Day temperatures were well above normal in the east and well below normal in the south-western hill-country, while night temperatures were above normal generally. The highest temperature recorded during the month was 97·4° at Batticaloa on the 13th, while the lowest temperature for a low-country station was 71·1° at Kurunegala on the 29th and for the whole Island 50·4° at Nuwara Eliya on the 23rd. Day humidity ranged from 75 to 85 per cent. in the wet zone and from 60 to 75 per cent. in the dry zone. Night humidity ranged generally from 80 to 95 per cent. Cloud amounts were above average and wind strength about average, the prevailing direction of wind being south-westerly.

D. T. E. DASSANAYAKE,
Director.

List of New Acquisitions to the Central Library, Peradeniya

1. The Pineapple Industry of the Hawaiian Islands—Cooke, F. C.
2. Thirty Five Millimetre Film Strip Technique—Hansell, P.
3. The Living Soil—Balfour, E. B., Revised Edition.
4. Forage Crops—Ahlgran, G. H.
5. Good Grassland—Robinson, D. H.
6. Good Farm Accounting—Campbell, A. C.
7. Good Milk Farming—Robinson, H. G.
8. Good Control of Plant Diseases—Glasscock, H. H.
9. Good Control of Insect Pests—Jary, S. G.
10. Water in the Physiology of Plants—Crafts, Currier & Stocking.
11. A First Course in Hygiene—Lyster, R. A., 10th Edn. (To Girls' Farm School, Kundasale.)
12. Modern Mothercraft—Pantin, E. (To Girls' Farm School, Kundasale)
13. Elements of Soil Conservation—Bennett, H. H.
14. Methods of Testing Rubber Latex, Part I.
15. The Butter Industry—Hunziker, O. F., 3rd Edn.
16. Principles of Crop Husbandry in India—Narayan Iyer, A. K. Y.
17. Agriculture : The Science and Practice of British Farming—Watson & More, 8th Edn.
18. Condensed Milk and Milk Powder—Hunziker, O. F., 6th Edn.
19. A Text Book of Dairy Chemistry—Ling, E. R., Vols: I & II, 2nd Edn.
20. Practical Bacteriology—Cunningham, A.
21. Bacteria in Relation to the Milk Supply—Chalmers, C. H., 3rd Edn.
22. Elementary Book Keeping—Munro, A., 13th Edn.
23. New Biology IV—Johnson & Abercrombie.
24. Dairy Engineering—Farrall, A. W.
25. Standard Methods for the Analysis of Ghee.
26. A Text Book of Physics—Devassy, C. P., Vols. I & II.
27. Report on the Marketing of Ghee and other Milk Products in India.
28. Report of the Co-operative Planning Committee, Bombay.
29. Milk Products—Harvey & Hill, 2nd Edn.
30. Milk Production and Control—Harvey & Hill, 2nd Edn.
31. Twelfth International Dairy Congress Proceedings, Vols. I–IV.
32. The Dairy Industry in Sweden.
33. Milk Yield and Profit of Milk Production at Different Seasons of Calving—Breirem & Homb.
34. The Production of Artificially Dried Grass—McNair & Fowler.
35. Indian Indigenous Milk Products—Davies, W. L.
36. Mathematical Treatment of the Results of Agricultural and other Experiments—Van Uven, M. J., 2nd Edn.
37. Manual of Bryology—Verdoorn, F.
38. Manual of Pteridology—Verdoorn, F.
39. Genera Filicum—Copelend, E. B.
40. Sampling Methods for Censuses and Surveys—Yates, F. (Issued to Botanist.)
41. Progress and Problems in Farm Mechanization—Acock, A. M.
42. Coimbatore Canes in Cultivation—Dutt & Rao. (Issued to Botanist.)
43. Cacao Production in South America—Erneholm, I.
44. Introduced Mammals of New Zealand—Wodzicki, K. A.
45. Families of Dicotyledons—Gunderson, A.
46. Plant Viruses and Virus Diseases—Bawden, 3rd Edn.
47. Annotated List of the Grasses of the Uganda Protectorate—Eggeling, W. G., 2nd Edn.
48. Laboratory Guide for a Course in General Biology—Bonar, Rouch & Holman.
49. Methods of Analysis—Lepper, Fisher *et al.*, 7th Edn. (Issued to A. R. O. N. C. D.)
50. Sugar Cane Culture in Egypt—Dillewijn, C. Van.
51. Field Instructions for Sugar Cane Planters—Dillewijn, C. Van.
52. A Pronouncing Dictionary of American English—Kenyon & Knott. (Issued to Sugar Expert.)
53. Plant Embryology—Johansen, D. A.
54. Veterinary Helminthology and Entomology—Monnig, H. O., 3rd Edn.

6—J. N. R 31690 (10/52)

55. Diseases of Field Crops—Dickson, J. G.
56. Nature and Prevention of Plant Diseases—Chester, K. S., 2nd Edn.
57. Farmers of the World—Brunner, Sanders *et al.*
58. Conserving Soil Resources—Chapman, Fitch *et al.*
59. Response of Crops and Soils to Fertilizers and Manures—Andrews, W. B.
60. Laboratory Manual of Parasitology—Ackert, J. E.
61. A Conservation Handbook—Ordway, S. H.
62. Experiments in Soil Bacteriology—Allen, O. N.
63. Elements of Dairying—Olson, T. M., Revised Edn.
64. Hormones and Horticulture—Avery & Johnson.
65. First Lessons in Bee Keeping—Dadant, C. P., Revised Edn.
66. Viruses and Virus Diseases of Plants—Cook, M. T.
67. Veterinary Protozoology—Morgan & Hawkins.
68. Sheep Science—Kammalade, W. G.
69. Principles of Servomechanisms—Brown & Campbell.
70. Structural Geology—Billings, M. P.
71. Principles of Food Freezing—Gortner, Erdman, *et al.*
72. Insect Transmission of Plant Diseases—Leach, J. G.
73. Farm Work Simplification—Vaughan & Hardin.
74. The Structure of Economic Plants—Hayward, H. E.
75. Using and Managing Soils—Gustafson, A. F.
76. Feeding Poultry—Heuser, G. F.
77. Nutritional Deficiencies in Livestock—Allman & Hamilton.
78. Farm Management—Black, Clawson *et al.*
79. Dairy Bacteriology—Hammer, B. W., 3rd Edn.
80. Commercial Fruit and Vegetable Products—Cruess, W. V., 3rd Edn.
81. Shopwork on the Farm—Jones, M. M.
82. The Commonwealth Relations Office List.
83. Manual of Veterinary Bacteriology—Kelser & Schoening, 5th Edn.
84. Principles of Field and Mining Geology—Forrester, J. D.
85. Bioenergics and Growth—Brody, S.
86. Beef Cattle—Snapp, R. R., 3rd Edn.
87. Veterinary Surgery Notes—Frank, E. R.
88. Principles of Field Crop Production—Martin & Leonard.
89. Chemistry and Uses of Insecticides—De Ong, E. R.
90. Bovine Mastitis—Little & Plastridge.
91. Outlines of Food Technology—Loesecke, H. E. W. Von, 2nd Edn.
92. Irrigated Soils, their Fertility and Management—Thorne & Peterson.
93. The Veterinary Adviser—Alexander, A. S.
94. Artificial Manures—Beaumont, A. B.
95. Fruit Science—Childers, N. F.
96. Small Fruit Culture—Shoemaker, J. S., 2nd Edn.
97. Commercial Fertilizers—Collings, G. H., 4th Edn.
98. Plant Physiology—Miller, E. C., 2nd Edn.
99. Modern Breeds of Livestock—Briggs, H. M.
100. Grass Silage and Dairying—Ingham, R. W.
101. A Text Book of Entomology—Ross, H. H.
102. Dairy Manufacturing Processes—Fouts & Freeman.
103. Corn and Corn Growing—Wallace & Bressman, 5th Edn.
104. Genetics of the Fowl—Hutt, F. B.
105. The Artificial Insemination of Farm Animals—Perry, E. J.
106. The Hive and the Honey Bee—Grout, R. A.
107. Cation Exchange in Soils—Kelley, W. P.
108. Dairy Science—Peterson, W. E., 2nd Edn.
109. Diseases and Parasites of Poultry—Barger & Card, 4th Edn.
110. Milk and Milk Processing—Herrington, B. L.

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The Tropical Agriculturist

The Agricultural Journal of Ceylon

Founded in 1881
by the late Mr. John Ferguson, C.M.G.

Published by
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Peradeniya, Ceylon.

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The Tropical Agriculturist

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The

Tropical Agriculturist

October to December, 1952

EDITORIAL

The Development of Animal Husbandry in the Island

THE development of animal husbandry in the Island has from time to time been the subject of enquiry and investigation by various local Committees and visiting livestock experts. But while, as a result of the useful reports issued, there have followed praiseworthy but isolated efforts on the part of a few individuals or organizations to take advantage of the opportunities offered for new enterprise, it cannot be said that there have been any marked advances either in regard to the systematic development of the industry on an Island-wide scale or in regard to its economic status.

Despite the fact that the neat cattle population of the Island exceeds the million mark, the production and consumption of milk continue to remain extremely low as gauged by the imports of dried milk powder for use at milk feeding centres, &c. This would indicate that by far the majority of our animals are unthrifty and of little value as milch cows, and/or that they are so neglected and ill-nourished, they do not even yield the small quantity of milk they are capable of. That the local Sinhala cow is generally uneconomic to maintain as a milch animal is confirmed by Dr. P. Mahadevan, Livestock Research Officer, in an article contributed to this issue of *The Tropical Agriculturist* on the results of his studies on the life and production statistics of the Sinhala cattle. The position in regard to the production of mutton and eggs for local consumption is not quite similar to that of milk, but the fact remains that the Island imported over 31 million eggs and from 5,000 to 6,000 goats each month during 1952. Only in respect of its beef requirements may the Island be said to be self-sufficient, and that because of the ban on the import of cattle into the Island for slaughter as a safeguard against the re-introduction of rinderpest.

What then are the reasons for the parlous condition of animal industry in the Island ? There are several, chief among them being the absence of a tradition of systematic animal breeding and management, and of mixed

farming in the country ; the restricted use of milk in the diet of its inhabitants ; the religious susceptibilities of many of our people in regard to the use of livestock as food ; the inadequacy and poor quality of our pastures ; the limited credit facilities offered rendering it difficult for those who have the knowledge to afford the means to embark on a new enterprise ; the absence, until recently, of organized marketing facilities for milk and other animal produce ; and the inadequacy of qualified personnel to organise the industry on an extensive scale. In order to remedy the backward state of the industry, the International Bank Commission in its report advocates the formulation and adoption of a long-term policy, particularly with regard to the breeding of cattle and the development of the milk supply. But any plans formulated for the development of an industry of the size and importance of dairy farming and animal husbandry generally would necessitate the fullest support and co-operation of all parties concerned with its successful execution. While Government through the research, extension, and supply services of the Department of Agriculture can foster and make a material contribution towards the development of animal husbandry in the Island, the fact remains that unless the people themselves, particularly those who have the means and knowledge to engage in the pursuit of livestock production, take full advantage of these facilities, little progress can be expected. Animal husbandry development in the country should be a co-operative effort between the Department of Agriculture and other Government bodies on the one hand, and organizations such as the Livestock Breeders' Association, the Colombo Co-operative Milk Union, the Ceylon Poultry Club, &c., and private parties on the other.

During the past few years the Department of Agriculture has intensified its efforts in various directions to promote the development of animal husbandry in the country, particularly in respect of dairying and poultry production. It realises that unless suitably-trained personnel are available, satisfactory progress with any animal husbandry programme cannot be made. Accordingly, a number of our officers have been sent abroad for training in various branches of the subject and a nucleus of qualified men in animal husbandry has now been secured. As a first step towards our planned objectives, the Division of Animal Husbandry has been re-organised to incorporate three separate branches, viz., Research, Management (Farms), and Production or Extension, each with distinct functions and activities. Already the partial re-orientation of the research and farm policy has begun to bear fruit. Our livestock farms of which there are now nine in the control of the Animal Husbandry Division serve the main purposes of determining the breeds of cattle and other livestock best suited for the various climatic zones of the Island and the most successful system of management under these conditions and of supplying selected breeding stock at reasonable prices to those engaged in animal husbandry activities. In addition, these farms have become important sources of supply of milk and other produce to hospitals, milk feeding centres, &c. Last year as many as 425,000 gallons of milk were supplied to these sources from all our farms. It is hoped before long that most, if not all, of them would serve as models for private enterprise to follow. Despite the

nigh overhead costs of Government undertakings and the sale of livestock produce at subsidised rates, a number of these farms will shortly pay their way.

Our extension service, in addition to making available veterinary aid for the control of animal diseases, is concerned largely with the establishment of stud centres in various parts of the country where stud bulls and goats of suitable breeds are stationed for the purpose of up-grading local stock. There are 286 such centres either entirely maintained or subsidised by the Department. The number of stud bulls at these centres is 530, while of stud goats there are over 170. Artificial insemination centres have also been started and six are now in operation.

The Department has also been alive to the importance of breeding draught and plough animals. With this object in view it has established three breeding farms for such cattle at Kilinochchi, Ridiyagama and Karagoda-Uyangoda respectively. At the last-mentioned centre, pure-bred Sinhala animals are being reared with the object of improving the milk and draught qualities of the stock on the station. The importance of breeding suitable buffaloes for paddy cultivation has not also been overlooked and for this purpose buffaloes are bred at five of our farms of which mention need only be made of Tabbowa, Ridiyagama and Polonnaruwa. The Indian Murrah buffalo has been imported so that suitable crosses with local animals may be obtained. It is hoped thereby to breed an animal which will combine good draught and high milk-yielding characteristics. A project which is contemplated for execution as soon as the facilities for doing so arise is the breeding, on a ranch scale, of the excellent Tamankaduwa cattle which over the years appears to have developed into a valuable dual-purpose animal.

In this issue of *The Tropical Agriculturist* Mr. H. Hirst who was, until recently, Adviser in Animal Husbandry under the F. A. O. Technical Assistance Scheme discusses the problems of animal husbandry in Ceylon and furnishes suggestions for their solution. This article merits the serious study of everyone concerned with animal husbandry development in the country. The long-range plan to which reference has been made in it represents the agreed views of the Department on the subject, and has been submitted to Government for its consideration. Reference is also invited to two other articles in this issue of this Journal, viz., those by Mr. Anker Ladefoged, General Manager of Livestock Farms, and Dr. Mahadevan. The important points brought out by Mr. Anker in his contribution are that the nutritive value of tropical fodder grasses is low compared with that of temperate fodders and that dairy cows in the tropics do not consume enough of these grasses even to meet their maintenance requirements. Increased attention to the management and improvement of our grasslands is therefore urgently required. The subject of pasture grasses and legumes, and fodders suitable for the different agronomic zones of the Island is being studied more intensively than in the past, and will receive the concentrated attention of an Agrostologist on his return from training abroad. Dr. Mahadevan's article has already been referred to and affords an interesting and authoritative study on the local Sinhala cow as a milk yielder. His view is that this low-producing animal which has only registered an annual genetic gain in yield by selection

of about half a gallon per year is not going to be the solution to our milk production. Alternative breeding systems, such as crossing with foreign breeds of superior performance and inter-breeding the progeny with a view to evolving a new type, have to be tried out.

It is not possible in a short editorial to refer to all that is being done by the Department in regard to animal husbandry, but mention should be made of the efforts to improve poultry production through the Colombo Backyard Poultry Scheme and the Schools Poultry Campaign, in addition to the normal extension activities which have been undertaken throughout the country, e.g., the issue of pure breed cockerels and eggs at subsidised rates to *bona fide* villagers, &c.

In concluding this review it would not be out of place to enumerate the various measures which are suggested for the material improvement of animal husbandry in the Island. They are as follows :—

(1) The provision of marketing and credit facilities to prospective dairy and poultry farmers. In this connection the creation of a Milk Board at an early date would be of valuable assistance to such organizations as the Colombo Co-operative Milk Union, &c.

(2) The establishment of Co-operative Dairying and Marketing Societies among smallholders.

(3) The integration of animal husbandry with crop husbandry in the dry zone. With this end in view, animal husbandry research is to be undertaken at the dry farming research station, Maha Illuppallama, a main line of investigation to be the study of breed-environment interaction. There is ample scope for the development of animal husbandry as a second " crop " under coconuts in the low-country.

(4) The intensification of research on pastures and fodders, and the provision of stock feed at reasonable rates to breeders. The maintenance of adequate grazing grounds and pasture lands in all parts of the country is of considerable importance in this connexion.

(5) The establishment of additional stud centres throughout the Island for the up-grading of stock, coupled with the starting of two or three more artificial insemination centres where the need for them is most felt. Together with these measures the registration of approved or selected stud animals and the castration of scrub bulls is also of fundamental importance.

(6) The formation of Young Farmers' Clubs to promote movements such as the Schools Poultry Scheme, Co-operative Livestock Clubs, &c.

(7) The intensification of our campaigns against disease control, e.g., Ranikhet disease of poultry, hoof-and-mouth disease, &c. This aspect of animal husbandry will receive consideration in another issue of this Journal.

ORIGINAL ARTICLES

Furthering the Supply and Consumption of Livestock Produce in Ceylon

(A Review of the Present Position and of Plans for the Future)

BY

H. HIRST

THE present and future importance of livestock to the economy of Ceylon is not always fully appreciated. While the use of modern machinery will undoubtedly play an increasingly important part in the reclamation and development of lands for cultivation and, under favourable circumstances for tractor operation, in intensifying production from lands already cultivated it is clear that unless there is a radical change in the system of land tenure, cattle, and in particular buffaloes, are likely to continue for many years to come to be the main source of power available to the local cultivator. The advent of a modern road system and the motor truck has undoubtedly reduced the need for the use of oxen for long distance road haulage but even so the use of draught cattle for short distance haulage, expecially on low country coconut estates, seems unlikely to further diminish in the foreseeable future.

The development of intensive livestock husbandry to provide a source of animal products for human food in Ceylon has, for a number of reasons, remained secondary to the use of livestock for draught purposes. It is now evident that well organised efforts will have to be made to improve the position in order to meet, by an increase in the local production of crop and livestock produce, both the need for an improvement in the present diet in Ceylon and the steadily mounting requirements of a rapidly increasing population much of which at present has to be met by importation.

As regards improving the diet the very high incidence of human tuberculosis, which mars an otherwise fairly good health record, demonstrates the need of a higher plane of nutrition through an increased consumption of foodstuffs, especially those supplying proteins of high biologic value, by a large proportion of the population.

The need for an increased consumption of proteins locally can be clearly shown by making a comparison with other countries. It has been calculated that in Ceylon the average daily protein intake per capita is 43·2 grams of which only 10·6 grams are of animal origin. By the same method of computation Burma, also a predominantly Buddhist country, is shown to have

a total protein intake of 66·5 grams per person of which 27·7 grams are of animal origin. In Denmark, a country in which the population may be regarded as having an optimum nutrition level the total protein intake and the proportion of it of animal orgin is some $2\frac{1}{2}$ and $5\frac{1}{2}$ times respectively than in Ceylon.

The recent drop in the value of estate crops, which form some 95 per cent. of the total exports and from which Government derives some 60 per cent. of its revenue, coupled with the necessity of subsidising imported foodstuffs has focussed attention on the urgency of increasing, by all possible means, the local production of cereal and secondary crops such as onions and chillies, which figure prominently in the local diet. This has tended to some extent to mask the need for the increased consumption of animal produce and the seriousness of the position as regards the future availability of livestock produce from overseas sources.

The bulk of the country's milk requirements which have been greatly increased of late years by the establishment of Milk Feeding Centres, is at present of imported origin and for the most part consists of powdered skim milk from Australasia, obtained as a by-product of the butter industry. International statistics show that butter is being gradually replaced in the diet of the Western world by substitutes of vegetable origin and that the milk formerly used for butter manufacture is being increasingly utilised for direct liquid consumption in the country of origin or for manufacturing products, having a higher sale value, such as whole milk powder. This indicates that Ceylon should not rely on obtaining large quantities of skim milk powder, at its present relatively low price, for any considerable period of time ahead.

The supply position as regards eggs is of concern in-so-far as, with decreasing availability and increased value on the world's markets, imports into Ceylon during recent years have very markedly increased. Despite efforts to increase local production, egg imports in 1951 rose by some 50 per cent. over those in the previous year and reached the record high figure of 24,000,000. Imports for the first six months of 1952 are estimated to be over 15,000,000. As from November 1, 1952, imported eggs must be stamped as such.

Mention also must be made of the supply position as regards meats. The import of cattle into Ceylon for slaughter has been prohibited for some time chiefly as a safeguard against the re-introduction of rinderpest. Periodic outbreaks of this disease have, in the past, caused serious livestock mortality and it is obviously desirable that the present embargo on imports of cattle be continued. Although the present local demand for beef cannot by Western standards be regarded as very great there are indications that it may be sufficient to cause a serious drain on the present and potential supplies of draught animals especially buffalo, many thousands of which are now required annually for Settlement Schemes.

The present supply of locally-reared goats is insufficient to meet the country's needs especially those of the Moslem population, and imports of goats from India are at present taking place at the rate of from 6,000 to 8,000

per month. In view of the availability of suitable goat food locally, especially in the drier zones of the Island, and the desirability of stopping imports of live goats from the disease aspect, it is obviously advisable for Ceylon to endeavour to become self-sufficient in goat flesh at as early a date as possible.

NEED FOR LONG-TERM PLANNING

In the past the need for increasing livestock productivity in Ceylon, especially of milk, has received the attention of a number of committees, local technicians and of visiting experts. Their conclusions have been recorded in a number of reports (1) (2) (3) (4) (5) (6) (7) which for the most part indicate the major shortcomings of the policies which have been pursued from time to time, stress what seemed desirable and in some instances made specific recommendations for action especially as regards the development of the State-operated livestock farms. Probably the most valuable of the more recent reports is that of Wright (6) made following his visit to Ceylon in 1945. This report, as stated in its preface, was primarily intended to furnish a basis for the long-term development of cattle breeding and milk production in the Island. The report stressed that in the past the attempts at livestock improvement, especially by the introduction of exotic breeds, failed to take sufficient cognisance of the environmental conditions under which improved livestock would have to be kept and of the need for a long-term and systematic approach to the many associated problems, especially that of providing suitable fodders for high yielding stock. The report mentions the paucity of reliable information on which to base future activities.

It was with this background in mind and with the prospects of obtaining overseas technical and financial aid from organisations, such as the Food and Agriculture Organisation of the United Nations, and the Colombo Plan, that the staff of the Department of Agriculture recently prepared a plan for the long-term development of the local livestock industry which has been submitted to Government as a basis for future livestock activities. This plan is in accord with the recommendations (8) of the International Bank Mission which visited Ceylon in 1951. The advice of the Mission " to remedy the present backward state of animal husbandry " is a " very long-term policy covering say 25 years " ; " a survey of existing livestock population and potential and the paying of special attention to the breeding of cattle and the development of milk supply ".

The Department's long-term plan re states and elaborates previously accepted policy aims in the light of existing circumstances, and provides for their periodic review during the period of 24 years covered by the plan. Its implementation programme makes provision for the continuity of the present activities of the Livestock Division of the Department with any modifications found necessary as a result of a survey of present animal husbandry status. It sets out the sequence of action it has planned to achieve in four periods, each covering six years which will coincide with the periods chosen by Government for its general development programmes. The programmes for the periods

subsequent to the first are in outline and will be revised and elaborated in the light of progress achieved and any modification of general policy which may be found necessary owing to changing circumstances.

In order to implement these programmes a series of Working Plans will be prepared. These will be drawn up, as found necessary, at a level and in sufficient detail to allow their easy implementation. It is hoped by the use of these Working Plans to keep the programmes essentially objective in character and free from the elaborate detailing of action which undoubtedly would, in many instances, prove difficult to follow in the years to come and might eventually lead to their abandonment.

FIRST SIX-YEAR PROGRAMME

Expressed briefly the programme for the first six-year period (1953–8) calls for the following new activities :—a detailed survey of the present animal husbandry position in the zones of the Island having differing environment, and an appraisal of development potential ; the establishment of three animal husbandry research centres (one in the dry zone, one in the low country wet zone and one in the montane area) ; the development of a Veterinary Research Centre with increased laboratory facilities for the preparation of veterinary biologics ; the formation of a new section of the Livestock Division to deal with Animal Production ; the strengthening of the Animal Husbandry and Veterinary Extension Services ; the establishment of local centres to enable annual courses of training in Animal Husbandry and Veterinary Hygiene to be given to both officials and non-officials ; the overseas training of additional technical personnel especially those required for research activities ; the development of the milk and poultry industries, and a pilot scheme approach to a number of projects which if successful might prove of considerable economic importance to the country.

ANIMAL HUSBANDRY RESEARCH

It has been decided to incorporate animal husbandry research with the crop investigations which are to be carried out at the new Dry Farming Research Station at Maha Illuppallama (North-Central Province) which is being established with the aid of a grant of £250,000, sterling made by the New Zealand Government under the Colombo Plan. It is intended to instal a psychrometric chamber at this centre which will allow the carrying out of fundamental climatic stress studies with livestock, especially with cattle. In view of the previous disappointing results, especially in the low country wet zone with exotic breeds of milch cattle considerable importance is attached to the outcome of this work. The availability of a psychrometric chamber should greatly facilitate breeding and environmental interaction studies which will include cross-breeding between indigenous and exotic breeds and efforts to develop local types of cattle which appear to have possibilities for milk production especially when kept by small producers.

The choice of a dry zone rather than a wet zone centre as the site for a psychrometric chamber has been influenced by the fact that while it is relatively easy to artificially simulate wet zone conditions by the addition of water vapour to a dry atmosphere it is much more difficult to remove moisture from a wet atmosphere in order to simulate dry zone conditions.

Concurrently with the breed environment work it is intended to carry out nutrition studies especially as regards the use of cut fodder crops for cattle and browse drops for goat feed. It is increasingly appreciated that in the past, when introducing improved livestock into an area far too little attention has been paid to improving the available fodder supply. While the direct effects of climate have undoubtedly played an important part in the low country wet zone in limiting production, especially from European type cattle, the poor nutritional value of deceptively lush tropical vegetation is also a limiting factor and probably accounts, to a considerable extent, for the poor performance of the Indian breeds of milch cattle which have been introduced into the wet zone.

Some research work with poultry has already been started and this will be expanded. As in the case of cattle the main task will be to develop types suited to the conditions under which they will be kept. It has been realized for some time that the rate of improvement being attempted with poultry, especially in some of the more backwards areas, is probably far too rapid.

There seems no point in giving small-scale peasant producers well-bred poultry, capable of producing 200 or more eggs per annum, if they are to be neglected and only allowed access to feed which will permit them to lay, say, from 50 to 100 eggs per year.

STATE LIVESTOCK FARMS

At present the Livestock Division is directly responsible for the management of six of the major livestock farms which cover over 15,000 acres, carry some 4,000 head of stock, and employ on an average about 650 labourers. In addition there are other stations, some of which have considerable numbers of milch animals, which come under the control of the District Agricultural officers. The direct control of cattle farms by the Livestock Division has on the whole proved very successful. Already a very noticeable improvement (9) has been achieved in the production of fodder crops on these farms in an effort to provide a continuity of supply for consumption by livestock throughout the year. This coupled with the improved fertility and health of the stock has resulted in increased milk yields which are rapidly reducing the financial losses previously experienced with these farms.

Carefully kept production and breeding records are now being supervised and analysed and form a basis for the programme, already embarked upon which involves the progeny testing of young bulls in the main herds. (10).

It is hoped that in the near future the Livestock Division will be able to assume direct responsibility for the management of further stations and in particular the two Government-operated dairies in the vicinity of Colombo.

At the present time considerable emphasis is being placed on the running of the Government livestock farms so as to produce on an economic basis the maximum amount of livestock produce, especially milk, for sale. It is realized that in the future, especially when the results of the survey of animal husbandry status and potential in the country become available, that renewed attention will have to be paid to meeting the specific needs of livestock keepers, in the differing evironment zones, for breeding livestock especially for stud bulls. At present, for example, as a result of the establishment of large dairies of European cattle during war years the Department is able to produce far more bulls of European breeds than for which a demand exists. It is, however, at the same time unable to meet the full demand for stud bulls of the Zebu breeds imported from India.

The present policy, and that which it may prove desirable to adopt in the future, need not prove inconsistent provided adequate forethought is given to the periodic reorientation of activities necessary to meet changing needs. Actually the original aims of many of these stations may well prove to coincide very closely with those which will be required in the future. These aims appear more likely to be fulfilled now that experience has been gained in developing management techniques which allow subsidiary livestock products to be produced and sold on an economic basis.

PILOT SCHEME APPROACHES

If animal husbandry, of a much more productive nature than in the past, is to be successfully integrated with crop husbandry so as to effectively minimise the dependence of Ceylon on importation of foodstuffs, it is deemed desirable that concurrently with research there should be a pilot scheme approach to a number of projects which, if they could be successfully adopted on a large scale, might prove of considerable consequence to the economy of the country. Several of these projects will probably need overseas aid, both as regards capital, finance and technical advice, even in their pilot stage. Falling in this category is a project calling for the establishment of a model milk producing colony and processing plant, on lands well outside but within easy reach of Colombo, on the lines of that at Aarey, Bombay State, to which milk producers, unfavourably situated in urban areas of Colombo, for the production of fodders or the rearing of young stock, would be induced to move.

Another project calls for the establishment of Village Livestock Units in association with rural youth clubs and school activities. Each of these units would have facilities for keeping 25–50 head of milking stock and for the rearing of their progeny. In addition to milking and rearing sheds, fodder stores, and a communal silo each unit would have a water supply and a fenced area for fodder growing. Milk produced on these co-operative units would be sold to Milk Feeding Centres at present relying on the use of imported skim milk powder.

One project which has already been started on a small scale, and which should be capable of development on a much larger scale on a self supporting basis, is that of making use for animal husbandry of undeveloped areas of the

dry zone which will not be required for intensive settlement for some years to come. Preliminary trials in the underbrushing of jungle, by the use of goats, are already in progress at Polonnaruwa and these will be extended as rapidly as possible. It is intended that goat grazing in these areas shall be properly controlled and that the goats should not be permitted to degrade the land by uncontrolled grazing as has taken place in parts of India and in certain Middle East countries. By making a systematic approach to the use of these undeveloped lands which in the latter stages would involve levelling and drainage, it is hoped to have the soil suitably ameliorated before intensive settlement takes place. In addition to developing ground pasturage attention will be paid in suitable areas to the establishment of deep-rooted bushy legumes for livestock feed, which from trials already conducted, appear to hold considerable promise.

Another project which may prove of considerable consequence to the development of animal husbandry on low country estates is the establishment of a fodder processing plant which is to be run in association with the new Government Vegetable Oil Refining Factory. This fodder processing plant, the equipment for which is already on order, will be capable of turing out some 40,000 tons of processed compound fodder per annum in the form of compressed nuts, poultry pellets or meal. This fodder will consist of the chemically extracted poonac, mixed with what other foods may become available locally (fish meal, rice bran, &c.). The Department of Agriculture hopes to obtain a smaller unit capable of producing up to 5 tons per hour of fodder, through which it can experiment in producing suitable feed mixtures using local foodstuffs. The availability of molasses and other by-products from the local sugar industry at present being fostered would prove of especial value to this project.

CONTROL OF LIVESTOCK DISEASES

The position in Ceylon as regards the control of the more serious livestock diseases may be regarded as reasonably satisfactory when compared with that in other Eastern countries. Rinderpest has been eradicated and anthrax is fairly effectively controlled. Foot-and-Mouth and Ranikhet (Newcastle) disease are, however, endemic and undoubtedly considerably lower livestock productivity. A condition known as lumber paralysis, which often proves fatal, has largely negatived attempts at improving the local goat, both for milk and meat production. Although a good deal has been found out recently about this disease, especially as regards the causative agent, no means of control have yet been found.

An investigation is to be made in connection with the survey of animal husbandry into the seasonal and aerial incidence of parasitic and other chronic diseases of livestock which may lower livestock productivity just as seriously as epidemics of acute disease.

The desirability of developing the Veterinary Services so as to be in a position to cope more adequately with chronic and recurrent disease conditions is becoming increasingly appreciated. In addition to the need for a well equipped Veterinary Research Centre and for more adequate laboratory space and

equipment for the preparation of veterinary biologics, it is felt that the field service needs to be strengthened. If funds can be obtained it is planned to establish District veterinary centres and also to acquire mobile field units (with laboratory and staff accommodation) which should place the field staff in a much stronger position to take prompt action in the event of an outbreak of disease and also to take timely prophylactic treatment against recurrent disease. It is hoped to organise systematic campaigns aimed at eradicating, or at least effectively controlling, endemic diseases such as Foot-and-Mouth disease and Ranikhet disease of poultry.

ENCOURAGING PRODUCTION AND OVERCOMING MARKETING PROBLEMS

Dairy Products

An investigation is being made into the present position as regards milk production and consumption in urban areas especially in Colombo. This is intended to supplement information to be obtained as regards the overall milk supply and consumption situation under a preliminary Island-wide survey of animal husbandry. From these surveys it is hoped to determine the major limitations to new and increased production of milk and to devise ways of overcoming them.

A draft Bill to provide for the establishment of a Milk Board to promote the production, processing, and marketing of milk is at present under consideration by Government. This Bill follows the recommendations in the report of the 1944 Milk Committee, and also the outcome of the deliberations of an inter-departmental committee appointed by the Minister of Health in 1949.

Difficulties in obtaining supplies of concentrated fodder for feeding to high-producing dairy stock is known to be one of the major deterrents to increased production and the possibilities of channelising, to milk producers, the concentrated fodders which are to be produced by the Cattle Fodder Processing Plant, associated with the new Government Vegetable Oil Refining Factory, seem worthy of full exploration.

Once it seems likely that some of the major limitations to increased production can be overcome it should prove possible, through the implementation of the provisions of the Milk Act, to encourage capital investment in the increased production of milk by the guaranteeing of either a long-term minimum price, or a definite purchase price subject to periodic review. Special consideration is likely to be given to encouraging the production of milk on low country estates, especially on coconut estates, where considerable areas of pasturage are already or could be made available.

It should be possible for the Milk Board, to be set up under the Milk Act, to facilitate in many ways the flow of milk from the producing to consuming areas. Apart from taking direct action the Board will be in a position to give technical and financial aid to organisations such as the Colombo Co-operative Milk Union which has already received a substantial grant from Government for the purchase of modern milk processing plant.

The possibility of establishing a pilot milk colony to which dairymen established in unsuitable areas of Colombo will be induced to move, has already been commented upon. The Co-operative marketing of milk is being encouraged wherever possible in the countryside, especially where there is an outlet for it in nearby Milk Feeding Centres which otherwise would have to rely on dried skim milk powder.

A matter for future consideration is the possibility of establishing milk producing colonies on newly settled areas of the Dry Zone, especially those favourably situated for the rapid transport of milk to consuming areas or as regards the availability of cattle fodders (i.e., near a sugar cane growing area).

The experience gained by the operation of the montane dairy farms, Bopatalawa and Ambawela, is to be critically studied with a view to extending the keeping of high producing European cattle in those localities.

Poultry Production

A similar survey to that being carried out in the case of the dairy industry is being attempted with poultry and, in view of the desirability of encouraging large-scale production, special attention is to be paid to the possibilities of increasing production on estates, especially under coconut and rubber. Small-scale trials in the keeping of poultry under a deep litter system at the Coconut Research Station (Western Division) and at the Wariyapola Farm (North-Western Division) appear to be proving successful.

With a shortage of grain for human consumption the supply of concentrated feed for large-scale poultry keeping ventures presents special problems. One solution may lie in the proposal to produce compressed poultry pellets (as a substitute for grain) at the Government Cattle Fodder Processing Plant. In addition to using chemically extracted poonac as a source of protein, the best use could be made of stored grains which become unfit for human consumption and of various local products such as fish meal which are available in rather limited quantities.

As in the case of the dairy industry it seems that the best way of stimulating the investment of capital in large-scale poultry farming ventures would be by providing suitable marketing facilities and by the giving of long-term guaranteed prices for produce.

A campaign to encourage the small-scale keeping of poultry by families is being intensified and special efforts are being made to interest school children in poultry keeping. If even a fraction of the household waste, which is at present scavenged by crows in urban areas, could be fed to domestic fowls a very significant increase in the local production of poultry produce could undoubtedly be achieved. One snag about the encouragement of small-scale poultry keeping is the fact that although it undoubtedly increases the local consumption of poultry produce it does very little to reduce the large imports of eggs which since the end of the war have tended to rise very rapidly.

As already stated research work as regards poultry husbandry will be aimed at producing types of stock suited to the needs of different classes of producers. It is felt that the many poultry fanciers in the Island might play an important part in supplying the needs of the ordinary poultry keeper for hatching eggs and breeding stock. One necessity is to persuade them to try to develop types of poultry suited to local requirements and not to worry about the keeping up of Western breed points for show purposes. With that in mind it is proposed to establish a Poultry Testing Station to which fanciers will be encouraged to send eggs for comparative hatching, rearing, and production trials.

Meat Production

It is considered that with the present number of cattle in the country there should be no great difficulty in meeting the limited demand for meats. Nevertheless care will have to be taken not to offer marketing inducements which would be liable to seriously deplete the numbers of breeding stock or of draught cattle, especially buffalo.

It is hoped under the long-term plan, for the development of the local livestock industry, to make a systematic approach to the use of the undeveloped areas of the Dry Zone for both goat and cattle rearing. It is desired to develop management techniques which will ensure that the land is not exploited but rather ameliorated for eventual cultivation. To achieve this it is probable that in many areas of the dry zone more attention may have to be paid to the establishment of deep rooted bushy legumes, such as lucaena glauca, than to ground pasturage. One large-scale trial on a private estate, in the systematic use of lucaena glauca loppings for goat feed has shown that as many as 20 goats per acre can be maintained on very poor grade sloping land, unsuitable for cultivation.

A preliminary investigation is being made into the incidence of parasitic and other chronic diseases of livestock whose effect on livestock productivity, especially of meat, might be just as serious as spasmodic outbreaks of acute disease. A local investigator, Crusz, has shown (11) that the extent of amphistomes and other fluke infestation in cattle especially in buffalo is alarmingly high. McGaughey has expressed the opinion (11) that parasitism with many species of helminths is a major cause of the poor condition and low production of local livestock. It is evident that a systematic approach will have to be made towards combating livestock parasites, especially in the dry zones of Ceylon, if meat production is to be practised on an economic basis.

It is not considered that there is much scope locally for the rearing and feeding of slaughter cattle under intensive systems, although it is appreciated that if improved food supplies such as those which may become available from the establishment of a sugar industry, and suitable accommodation could be arranged, it might prove economic to give many cattle a period of intensive fattening prior to slaughter. Much of the livestock at present slaughtered locally, is only in store condition and gives a very low percentage of good

quality edible flesh. While the local practice remains that of using meats mainly as curried side dishes it seems unlikely that quality meat will ever command, on retailing, the price premium it does in some Western countries.

SUMMARY

The future place of livestock in the economy of Ceylon has been reviewed.

The need for an improvement in the local diet by the increased consumption of more high-grade protein, especially that of animal origin, is shown.

Mention is made of the difficulties likely to be experienced in the future in obtaining supplies of livestock produce from overseas sources.

Previous attempts at improving the quality of livestock are mentioned and the need for a systematic approach to many livestock problems is emphasized if the local livestock industry is to be developed to meet the increased food needs of a rapidly increasing population.

The aims of a long-term (24-year) development plan prepared by the Department of Agriculture are outlined. The main items of the first six-year programme are described. Special attention is paid to the needs for livestock research and to the plan for the establishment of animal husbandry research centres in the three main climatic zones of the Island.

The present and future activities of the State-operated livestock farms are commented upon.

The advisability of making a pilot scheme approach to a number of development projects, which appear to hold considerable promise, is stressed. A number of such projects are described.

The present position as regards the incidence of livestock disease is favourably commented upon. The need to develop the Veterinary Services so as to be in a position to cope more adequately with chronic and recurrent disease, especially parasitism, is emphasized.

Means of encouraging production and overcoming marketing problems as regards dairy, poultry and meat products are dealt with in some detail.

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Table showing the Livestock Population from 1940–1951

Year	*Cattle*	*Buffaloes*	*Sheep*	*Goats*
1940	1,125,104	567,717	59,969	269,812
1941	1,168,371	592,092	62,828	314,162
1942	1,120,138	589,950	58,804	286,719
1943	1,081,678	568,891	53,403	263,653
1944	1,039,752	535,025	58,963	262,066
1945	1,254,652	557,276	57,350	272,087
1946	1,067,659	593,267	68,673	278,219
1947	1,115,807	624,168	55,303	326,386
1948	1,133,461	658,468	48,449	369,622
1949	1,240,747	656,052	57,349	573,015
1950	1,105,447	522,418	43,627	370,091
1951	1,112,360	567,672	72,600	411,320

Table showing the Number of Animals (including those Imported) slaughtered for Food from 1940–1951

1940	134,065	8,310	8,421	102,827
1941	140,030	10,859	9,325	109,457
1942	175,776	18,370	7,577	133,803
1943	105,736	16,587	2,039	86,318
1944	93,918	5,351	2,157	72,845
1945	82,617	3,084	1,118	53,853
1946	92,385	9,200	3,087	39,551
1947	111,322	8,642	10,526	36,938
1948	131,298	7,650	12,272	79,777
1949	127,775	9,054	11,138	69,440
1950	147,458	10,453	36,497	114,757
1951	151,790	10,282	48,923	108,673

A good crop of subterranean Clover on Patana Land, Bopatalawa Farm

A good crop of Rye on the Cattle Farm, Bopatalawa

Tamankaduwa Type Cattle on grazing grounds on the banks of the Mahaweliganga

The Performance of the Sinhala Cattle*

BY

P. MAHADEVAN

IT would appear from a survey of the available literature on dairy cattle breeding in the tropics that numerous schemes have been formulated in recent years for the development of the livestock industry in different tropical and sub-tropical countries. Desirable or otherwise as such schemes may be, the fact remains that their intrinsic value is offset to some extent by the more or less complete absence of any established facts relating to the livestock of these regions. A correct scientific approach to the problem of livestock improvement under tropical conditions would indicate that the establishment of facts and the elucidation of the numerous problems peculiar to these regions should form the first step to the formulation of any rational policy of livestock improvement. The present paper attempts to furnish some of the information that is necessary in this connection regarding a breed of tropical cattle in Ceylon.

SOURCE OF DATA

The material for this study was obtained from a herd of Sinhala cattle situated at Karagoda Uyangoda in the Southern Province of Ceylon. The farm lies approximately 6° N of the equator and has an average monthly temperature ranging from about 78° to 82° F. The average annual rainfall over the last fourteen years was 93 inches. Of this, 24 inches was received during the months of October and November and 12 inches in May, both of which together constitute two-fifths of the total rainfall. The rest of the rainfall was fairly evenly distributed through the rest of the year. January and February nevertheless often tended to be relatively dry months. The herd under consideration was started in 1937–38 on a total area of 107 acres. Local cattle of the black Sinhala type were purchased from different parts of the country and maintained on this farm in an attempt to determine the milch and draft potentialities of these animals. At the inception, only 2 stud bulls and 17 cows were purchased ; but, during the years 1939–1942, 22 more animals were bought in, and the present herd, consisting of about 125 head of cattle, has been built up almost entirely from these 41 animals—very little outside blood being introduced into the herd during the fifteen years of its existence.

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* A paper read at the Eighth Annual Sessions of the Ceylon Association for the Advancement of Science under the title " The General Life and Production Statistics of the Sinhala cattle."

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LIFE STATISTICS

The Sinhala cattle, which form the bulk of the cattle population of Ceylon, are characterized by their small size and stature and by the relatively poor development of hump and dewlap as compared with most other tropical and sub-tropical cattle. Their average birthweight on the basis of the present data was found to be 31 lb. for males and 29 lb. for females. It was also observed that calves from heifers generally averaged 2 lb. less at birth than calves from older cows. At maturity, the average weight of males was found to be about 600 lb. and that of females near 400 lb. The heifers have been generally put to the bull when they reached a liveweight of about 330 lb., and in consequence the average age at first calving has been 42·4 months. It seems reasonable to assume that if the rearing of calves was given greater attention, and the heifers brought to a good condition of flesh early in life, a late first calving could have been avoided. Experimental work in progress in this herd lends support to the view that it should be possible to induce early maturity in these animals by good feeding during the first six to eight months of life. The chief advantage of an early first calving is that it would decrease the average interval between generations and thereby tend to increase the rate of genetic improvement per year.

Regularity of calvings has been a noteworthy feature of the Karagoda-Uyangoda herd. The freedom from reproductive disturbances which this reflects seems to be characteristic of the Sinhala cattle. It appears likely that this regularity is due in large measure to the low milk yield of the cows—a point which we hope to verify, when more data accumulate, by a study of the genetic correlation between fertility and yield. Be it as it may, the average calving interval of 355 days is one of the lowest recorded for any herd of cattle.

The length of dry period, however, was exceptionally long and averaged 122 days. This means that the length of lactation was only 233 days. If the latter could be taken as a measure of persistency of yield, it would indicate that the persistency of the Sinhala cattle is very low. This was confirmed by a study of the shape of the lactation curves for first, second and later calvers separately. It has been suggested by some observers of the Sinhala cattle that one of the methods by which the length of lactation could be increased is " by selecting for breeding the cows with the longer lactation records ". It is however not possible to subscribe to this view for the reason that the repeatability of lactation lengths in this herd is low and not significant ($r = + 0{\cdot}12$).

It was also found that the coefficient of variation of lactation length in this herd was 0·22. The number of lactations ending before 200 days was as high as 25 per cent which is very much in excess of the corresponding figure of under 5 per cent. for European conditions.

The average length of productive herd life at Karagoda-Uyangoda worked out at around 5 lactations. The average length of *total* productive life, however, may have been higher than this, as it is known that some of the animals sold from the herd continued their milking life in other herds.

There seems to have been no well-defined policy as regards breeding. Very little voluntary culling of heifers has been carried out, but a consistent attempt appears to have been made to breed bulls from the better cows. This is reflected in the almost negligible selection differentials obtained for dams of cows and the high selection differentials for dams of bulls. But the genetic advantages gained by the good selection of bulls have been offset to a very considerable extent by the late age at which bulls were used for service. The average age of bulls at first service was 56 months, while the lowest age was as high as 40 months. As the criterion of the efficiency of any breeding programme is the improvement per year rather than per generation, it is evident that for a sound breeding policy, bulls should be used for service at as early an age as possible so as to cut down the generation length.

Since its inception, the Karagoda-Uyangoda herd has been treated more or less as a closed one, and in consequence the intensity of inbreeding has risen for heifers and bull calves born in recent years to an average of 15 per cent. The effect of the inbreeding on the birthweight of calves was studied by computing the intra-sire regression of progeny birthweight on dam's inbreeding after correcting for differences due to sex of calves and differences due to lactation number of dam. The results, though not statistically significant, suggest that there is a tendency for decrease in birthweight as a result of increase in inbreeding. It was however not possible to determine the effect of inbreeding on milk yield in this herd, because most of the animals with high inbreeding coefficients have not come into production as yet.

PRODUCTION STATISTICS

Perhaps one of the most characteristic production traits of the Sinhala cattle is the refusal of the dams to let down their milk if the calves are not allowed to suckle for some time at each milking. Repeated attempts with Sinhala heifers and cows to wean their calves at birth have hitherto not been successful. This is in striking contrast to the success we have had in weaning calves of other Asiatic breeds of cattle in Ceylon, and it is bound to be a great handicap if the Sinhala cattle are to be developed to any great extent as a pure breed for milk production.

The average milk yield per lactation in the Sinhala herd at Karagoda-Uyangoda as based on the total data was found to be 94 gallons, which was exclusive of the milk suckled by the calves during milking. It was found that the lower lactation yields in the herd were often associated not only with a low average daily yield but also with a short length of lactation—the correlation between total yield and average daily yield being $0 \cdot 82 \pm 0 \cdot 02$ and that between total yield and lactation length being $0 \cdot 44 \pm 0 \cdot 04$.

The possibility of increasing the average level of production in a given population by breeding methods is largely dependent on the amount of variability obtaining within it. The higher the within-herd variability for

milk yield, the greater are the chances of improvement of this trait. In the Sinhala cattle, the coefficient of variation of milk yield was found to be of the order of 39 per cent. as compared with about 20 to 22 per cent. for cattle in temperate countries. This suggested that selection would be worth persevering with to some extent in the Sinhala cattle.

The effect of age at first calving on yield in the first lactation was analysed, and the regression value of 0·13 gallons that was obtained for an increase in age of one month was not significant. On the other hand the variation of yield with age in lactations was found to be considerable, though not so great as in European breeds. This variation is shown by the results obtained by the " paired-lactation " method, which eliminates most of the influence of selection. (*See* table).

Yield in	*1st Lact :*	*2nd Lact :*	*3rd Lact :*	*4th Lact :*	*5th Lact :*
..	79 galls.	84 galls.	84 galls.	91 galls.	80 galls.

The trend appears to be rather uneven, probably because of the small numbers involved. One fact that emerges fairly clearly is that peak production was generally attained by the fourth lactation which was reached when the cows were about six and a half years old. The rate of increase was such that by the time the cows had completed four lactations their yields had risen about 15 per cent.

A study of the distribution of calvings in this herd showed that the calvings were fairly evenly distributed throughout the year. Cows calving in June and November gave about 10 per cent. more milk than those calving in other months of the year. There is some suggestion that this may be related to the heavy rains of May and October.

The average repeatability of milk yield in this herd was studied by considering all cows that have had two or more lactation records. The first lactation appeared to have a lower repeatability than subsequent ones. This suggested that culling on first lactation should be carried out for heifers giving very little milk only. Culling on second lactation, however, should be much more rigorous, and in fact all culling for production performance should be completed by the end of the second lactation. The average repeatability, as obtained by weighting each of the independent estimates by the reciprocal of its squared standard error, was found to be 0·46. This figure is in close agreement with the results reported by various investigators for European cattle.

A reliable estimate of the heritability of milk yield within the herd could not be arrived at owing to an inadequacy of daughter-dam pairs. The estimates of repeatability nevertheless lend support to the view that heritability would probably be of the order 0·25—0·30. Such a figure would be of value in considering the probable genetic changes that could be brought about by selection.

We have actually used the figure 0·25 to estimate the probable rate of genetic improvement by selection in this herd over a period of thirteen years, and have obtained a value of 0·6 percent. of the average yield per year. Barely one-sixteenth of this came from the selection of dams of cows while the remainder was due to good selection of dams of bulls.

DISCUSSION

It would appear from this study of the general life and production statistics of the Sinhala cattle that, among other things, the need for an early first calving and for a reasonably long lactation period had not been sufficiently appreciated during the period under review. Despite the fifteen years of existence of the farm at Karagoda Uyangoda, the age at first calving in 1951—which forms the last year under review—was even higher than the average age for the whole period 1937 to 1951 by about 6 months. The length of lactation in 1951 was also shorter by approximately three weeks. Experimental work now in progress at Karagoda-Uyangoda suggests, however, that with good feeding and management in early life it should be possible to rear heifers to maturity within a period of two years. Moreover, the results of our statistical analyses indicate that since the repeatability of lactation lengths is only 0·12, efficient management might bring about a positive response in lactation length as well.

Another interesting point that emerges from this study is that in spite of the relatively greater length of productive herd life and its effect on herd replacements among the Sinhala cattle, as compared with cattle in European countries the intensity of culling in this herd has been disappointingly low. If the high average age of cows and bulls at first service is added to this fact, one would have a fairly clear picture of the limitations that have hitherto been imposed on the breeding of Sinhala cattle at Karagoda-Uyangoda.

But it would be appreciated that even under optimum conditions of selection the rate of genetic gain in milk yield would hardly exceed 1 per cent. of the average yield per year. Obviously, this does not hold out much hope of rapid improvement in a herd with an average lactation yield of under a hundred gallons. Alternative breeding systems need to be tried out, such as crossing the local stock with a foreign breed of superior performance and interbreeding the progeny with a view to evolving a new type. From the standpoint of theoretical quantitative genetics there is no valid reason why such a method should not prove successful. In fact, it is interesting to note that it has met with practical success in the formation of a new breed of dairy cattle in Jamaica and also in the evolution of beef breeds elsewhere. It is hoped that the crossing experiments that we have now initiated at Karagoda-Uyangoda under closely controlled conditions would prove equally successful, and that the preliminary results would be available within about 4 to 5 years.

Some Aspects of the Feeding and Efficiency of Dairy Cows

BY

A. V. ANKER LADEFOGED

THE efficiency with which various kinds of livestock convert the gross energy of the feed they consume into energy in human feed varies greatly. Taking our livestock as a whole only a fraction of the energy is recovered in animal produce. Leitch and Godden for instance arrived at the conclusion, that in Great Britain under conditions of adequate feeding only 8·7 per cent. of the energy in the digestible nutrients consumed by all livestock would be recovered in the different types of animal produce. Measured on the basis of the efficiency with which they convert either digestible nutrients or nett energy into human food, dairy cows rank first among all livestock. Furthermore, the food of the dairy cow consists mainly of substances which are unsuitable for human consumption, while the food of, for instance the pig and particularly that of the fowl, come very near that of man. It can be said in general, that our livestock, including the dairy cow, are somewhat inefficient in the sense that they must consume large amounts of material before they begin to produce anything at all.

The low percentage of transformation, which even in the case of high producing dairy cows does not come to more than 30 per cent., and the fact that feeding stuffs total more than half the cost of milk production are the main limiting factors for the output of dairy produce, not only for the world household economy as a whole, but also for the individual dairy farmer's economy. It is of the greatest importance therefore, that we utilize the potentialities of our dairy cattle as efficiently as possible and feed them with food produced as cheap as possible, preferably such food which fit into our agricultural system in rotation with crops for human consumption.

The value of a dairy cow is determined by (1) her capacity to produce milk, (2) her capacity to breed regularly and to pass her good qualities on to her offspring and (3) the length of her useful life. High yields are apt to be reduced by ill health and a sound and strong constitution is therefore very essential. Good animals kept in good health will make better use of food resources than the poor and indifferent ones and therefore in order to obtain the best results good feeding must be combined with efficient breeding, selection, rearing and management.

No less than about half the total quantity of digestible energy consumed by an average good dairy cow is used for the maintenance of her body, heat production, &c. (In the resting condition all the metabolic processes continue to function and a certain amount of energy is therefore required) if for instance a cow is producing about 30 lb. of milk with 4 per cent. fat daily, just about

half of the digestible energy is required for maintenance and of the second half—the production ration—which is used for milk production only about $\frac{2}{3}$ will be recovered in milk. The other $\frac{1}{3}$, or $\frac{1}{6}$ of the total amount of food, is lost as energy required for the process of milk formation. It will therefore be seen in this example, that the energy loss for maintenance is 3 times as great as the energy loss for milk formation. In the case of low producing cows much less than half of the total amount of food digested is used for milk production. For a cow, for instance, producing 300 gallons of milk with 4 per cent. fat in a year only about 40 per cent. of the ration will be used for milk production, while 60 per cent. will be used for maintaining her body. This clearly stresses the economical importance in dairying of the maintenance ration which varies only according to body size, but is the same for low and high producing cows. An animal that eats no more than maintenance ration has obviously an efficiency of zero and the efficiency rises as production increases. For milk production we must aim at keeping cows with a low maintenance requirement and with a capacity to deal with large amounts of food for production. The maintenance ration must supply a certain minimum amount of energy represented in terms of digestible protein and total digestible nutrients in order to maintain the animal in constant weight and health. Furthermore the maintenance ration has to supply the animal with all the essential minerals and vitamins as it by no means follows, that because an animal is doing no work or producing no milk, that any of these aspects of its ration can be neglected for any length of time. The food for maintenance has therefore to be of a high order both in regard to quantity and quality and this holds good to an even greater extent in feeding for milk production. Animal digestion does not, of course, recognize any such division between the maintenance ration and the food for production, but deals with the total nutrients supplied. For the practical dairy farmer this division may not appear to have any importance, as he is feeding not only to keep his cows alive, but also to obtain an economical profit. The division, however, makes it possible for him to estimate as to how much of the total food fed of necessity is used for maintenance and therefore lost for production and thus enable him to calculate the expenditure involved in food before a certain production can be achieved.

The milk producing capacity of a cow is essentially inherited and for most high producers combined with a strong constitution. As a rule additional feeding beyond the inherited capacity of a cow will not influence the amount of milk to any appreciable degree. Any additional food given in an endeavour to increase the milk still further will be wasted, as all that the cow can do is to store the excess nutrients in the form of body fat. This is a very important point to keep in mind particularly when dealing with cows of low producing capacity, a fact which is often overlooked in this country. An experiment carried out at Polonnaruwa Livestock Farm with 10 low yielding Scindi cows proved this theory. From the date of calving these cows were fed very liberal amounts of concentrates in order to find out whether this would stimulate the milk yield to any considerable extent. The milk yields, however, were hardly affected by this heavy feeding, but the cows put on weight. On the other hand it is evident, that after allowing the cows

enough feed to cover their maintenance requirement, it would be poor business not to furnish the full production ration and thus meet the complete requirement of the cow for milk she is capable of yielding. The economic importance of increasing the output of milk per cow and her efficiency to transform feeding stuffs into milk, has led to several experiments investigating into the possibilities for reducing the maintenance requirement by artificial means, mainly by controlling the activity of the thyroid gland. The opinions as to the possibilities in this field are, however, very varied.

The nett energy for maintenance should primarily be produced by roughage,the value of which unlike those of concentrates are still not adequately known. Several authors have given formulae for estimating the digestibility of roughage from figures for protein and crude fibre with the aid of regression equations, but more precise methods are still needed as marked differences are found in the estimation of different roughage. Experience in various temperate zone countries shows, that relatively good milk yields can be obtained by feeding roughage alone ; however, if higher yields are to be reached, or if the production capacity of a good cow is to be fully utilized, the administration of protein rich concentrates is generally necessary. It is very common in those countries to see cows yielding even as much as 30 lb. of milk daily being fed solely on hay, grass, roots or silage, but as a rule it can be said that the feeding of roughage provides food not only for maintenance but also for good part of the milk produced. The application of new technical developments will undoubtedly enable the Livestock industry in those countries to rely still more on farm grown fodders and pastures and thereby help to reduce the cost of production and also make the dairy cow still more useful in their agricultural system.

In the tropics the contribution of roughage to rations for dairy cows seems to be entirely different from that of temperate countries, and even when considering the roughage fed the need for supplementary feeding of concentrates in the tropics is much greater than one actually would expect. The main reason for this seems to be the difficulty of providing the dairy cow in the tropics with an adequate supply of green fodder of high nutritive value. Most of the more advanced dairies in Ceylon adopt a system of " partial stallfeeding " where the cows are allowed a certain amount of grazing, while the bulk of the feed, composed of fodder-grass and concentrates, is fed in the stall, the most commonly fed grasses being Napier and Mauritius grass. The amounts of these grasses consumed by cows are, however, surprisingly low when compared with the roughage intake by dairy cows in temperate zones. Feeding trials carried out at Polonnaruwa Livestock Farm showed that the maximum amount of Napier grass (harvested when 4 ft. high during rainy season) a full grown Scindi cow in milk woud consume was just about 60 lb. daily. Similar, but more comprehensive experiments carried out in Jamaica had shown a daiy consumption of 51 lb. of Napier grass by 825 lb's cows and that this ration would furnish a cow of this weight giving 14 lb. of milk with only 2/5 of the energy and $\frac{1}{4}$ of the digestible crude protein, or not even enough to meet the maintenance requirement. This very low figure for consumption (cows in temperate countries consume freely

125—150 lb. of grass daily) and the low nutritive value make such grasses unsuitable for feeding high producing cows, unless they are cut at a very young stage, and they must of necessity create a need for heavy feeding of high protein concentrates. It should in this connection be kept in mind, that the process in ruminants, involving as it does, rather prolonged bacterial fermentation, is well adopted to make use of roughage, but is wasteful as regard big quantities of concentrates. The failure on the part of cows in the tropics to consume bigger quantities of these fodder grasses has not yet found its explanation. It might be that the nutrition of dairy cows is not merely a question of feeding the cow, but also a question of feeding properly the cellulose splitting bacteries in the rumen. While experience and research work have shown the types of food required for maintenance and increased production in milking cows, it is only now that evidence is beginning to accumulate on the part played by minor or trace elements and the microbiological activity in the alimentary tract.

We should in this country try to get away from the heavy feeding of concentrates necessitated by the feeding of coarse fodder grasses. The way to cheaper and more rational feeding of dairy cows in the tropics should be to turn from the feeding of coarse fodder grasses to finer leafy and more succulent fodders and pastures. Considerable attention should be devoted to better management of our grasslands in order to obtain improved quality and increased production. Appropriate measures in this direction would produce more effective results than any other means, as pastures and preferably mixed pastures with both legumes and grasses, without comparison are the cheapest source of food for dairy cows.

SUMMARY

About $\frac{2}{3}$ of the total quantity of digestible energy in the feed for milk production is " lost " for maintenance and milk formation. The loss for maintenance is 3 times that for milk formation.

Milk yields are proportional, not to the total ration, but to the amount of food eaten over and above the amount required for maintenance, hence the heavier yielder is the more economical producer.

The nutritive value of tropical fodder grasses is low when compared with that of temperate zone fodders. Dairy cows in the tropics are not able to consume enough of these grasses to meet even the maintenance requirement. Heavy feeding of concentrates is required if coarse fodder grasses are fed.

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Cultivation of Pineapples

BY

A. V. RICHARDS

THE pineapple (*Ananas sativus L.*) is a popular fruit native to tropical America from where it has been introduced into other parts of the world. It is grown extensively in Hawaii, Malaya, South Africa, Florida and Queensland. The fruit is rich in vitamins A and C, and contains a proteolytic enzyme, bromelin, which is believed to aid digestion.

SOIL AND CLIMATIC REQUIREMENTS

Pineapple grows well on a wide range of soils from lateretic gravel to sandy loams, but it is not tolerant of poor drainage. Poorly drained clay loams are unsuitable since they favour the development of basal rots caused by the fungus *Thielaviopsis paradoxa*. The best growth is made on slightly acid sandy loams which are well drained and fertile. An excess of manganese or lime in the soil is also harmful since it makes iron unavailable to the plant and causes yellowing of the leaves.

Although pineapple is fairly resistant to drought it requires a well distributed rainfall for good growth. In Ceylon the best pineapples are produced in the low-country wet and semi-dry zones between Gampaha and Madampe.

VARIETIES

The two popular local varieties are the Kew and Mauritius. The Kew is almost identical with the Smooth Cayenne, which is the principal canning variety. The leaves of this variety have smooth margins, and the fruit is large, pale fleshed with flat, broad " eyes ", whereas in the Mauritius the leaf margins are serrate, and the fruits relatively small, yellow fleshed with somewhat pointed " eyes ". Mauritius being generally sweeter and smaller than Kew is used as fresh fruit and seldom canned. There is also a semi-wild variety with serrated leaf margins known locally as *Gal annasi* which produces acid fruits.

PROPAGATION

Propagation is from ratoons, suckers, basal slips, crown slips, crowns and even butts of old plants. Ratoons arise from below ground level, suckers from axils of leaves, basal slips from the fruit stalk, crown slips from the base of the crown on the fruit (Fig. 1).

Ratoons are relatively scarce, but suckers and slips are plentiful immediately after harvest. In Queensland butts of old plants are planted lengthwise 3 inches below ground level when suitable planting materials are scarce.

Suckers (Fig. 2a) take from 14 to 16 months to come into bearing, slips from 18 to 20 months, and crowns about two years depending on the variety, Mauritius being earlier than Kew. Crowns are available in large numbers at the canneries during the season, and though slow growing produce a vigorous, uniform stand of plants which tend to come into bearing at the same time. Care should be taken to discard all inferior bud sports or off-types such as " collar of slips " and " near collar of slips " in which the slips tend to grow out from the base of the fruit itself. Planting materials should be taken from selected healthy plants which produce barrel shaped fruits that could be trimmed to fit the can without much wastage ; conical fruits with tapering ends require much trimming.

In order to prevent development of fungal rots all planting materials should be stripped of the basal leaves (Fig. 2b) and cured by exposure in the sun for a few days after dipping the trimmed ends in 5 per cent. solution of potassium permanganate or other disinfectant (Fig. 2c).

PLANTING DISTANCES

Planting is best done in double rows spaced 2 feet apart with the plants 1 foot in the row, and the centres of each pair of double rows 5 to 6 feet apart. The number of plants at this spacing is about 10,500 per acre, but the Mauritius variety could be planted slightly closer with an average of 12,000 plants per acre.

But if weeds such as Kora (*Cyperus rotundus*) are troublesome the planting may be done in single rows spaced 4 feet apart to facilitate weeding by tractor drawn implements, but where possible double row planting should be done since it provides better support for the fruit which would otherwise tend to topple over.

Deep planting is undesirable since it retards the growth of the suckers and may even cause death if the soil gets into the heart of the plant. A shallow depth of 3 inches is best for suckers of average size, but large suckers could be planted 4 to 5 inches deep.

MANURING

Pineapple plants respond to applications of quickly available fertilisers. In Queensland the fertiliser mixture consisting of sulphate of ammonia, superphosphate and sulphate of potash in the proportion of 10 parts nitrogen, 6 parts P_2O_5 and 10 parts K_2O, is applied in the axils of the basal leaves at the rate of 50 lb. per 1,000 plants or roughly a handful to three plants about a fortnight after planting in September and again in January–February. In addition sulphate of ammonia is applied at the rate of 30 lb. per 1,000 plants in November and March–April each year. On sandy soils copper and zinc are included at the rate of 56 lb. each of copper sulphate and zinc sulphate per ton of this 10·6·10 fertiliser mixture to correct a peculiar deficiency disorder known as " crook neck " in which the centre leaves bunch and bend over

almost parallel to the ground. The fertiliser mixture is applied with the flick of the wrist into the axils of the basal leaves where it dissolves in the rain water and is readily absorbed in solution by the axillary roots. But if applied into the centre of the plant it is likely to damage the young leaves severely.

Chlorosis of the leaves due to iron deficiency caused by excess of manganese or lime in the soil is cured by spraying the foliage with 3 per cent. solution of ferrous sulphate every 4 to 6 weeks.

MULCHING

The use of coir dust, cut grass, or other organic matter as a mulch is beneficial since it helps to keep down weeds, lower the soil temperature, and conserve soil moisture. A special type of paper is used for this purpose in Hawaii where labour costs for weeding by hand in the rows are prohibitive. The use of pre-emergence sprays for the control of weeds is a new development which shows promise in Australia. Under favourable conditions the weedicide is effective for several weeks in destroying any weeds that germinate, but heavy rain is likely to wash it down..

FRUITING

The Mauritius variety comes early into season in February–March while the peak of production for "Kew" is in June–July. An off season crop may also mature in November–December.

Well-grown plants could be made to fruit early and uniformly by the application of an aqueous solution of acetylene gas on the growing point. This is done by placing a handful of carbide in a 4–gallon tin of water and pouring about $\frac{1}{3}$ cupful of the fresh solution into the heart of each plant. There should be no rain within 48 hours of application for the treatment to be effective. Acetylene treatment at the proper time promotes flowering in 6 to 7 weeks' time, and stimulates production of suckers at lower levels where they are not likely to break off with the weight of their fruit the following season. Small plants will also flower when treated with acetylene, but the fruits will be too small for marketing. Only plants with more than about 30 leaves should be treated.

The hormone—Alpha naphthalene acetic acid—is equally effective in inducing early flowering. It also tends to delay fruit maturity and increase fruit size when sprayed on the fruit early in the season.

The sugar content increases as the fruit matures, and the colour changes from green to orange yellow. Fruits for canning are picked before they are quite ripe. The barrel shaped fruit which will fit the can is preferable to the long conical type.

Well managed pineapple fields can be cropped for five years or so after which the plants become weak and unthrifty.

Crows, squirrels and even pole-cats attack maturing fruits which have to be protected by covering them with the basal leaves and straw.

The mealy bug is also a troublesome pest on pineapple. It is carried from plant to plant by ants and is believed to be responsible for the wilt disease (Fig. 3) which is now prevalent in the Gampaha area where several holdings have gone out of production. The use of clean, disease free planting material and the control of ants by suitable insecticides will help to prevent the spread of the disease. The roots of the diseased plants die and the leaves wilt and bend over. Basal rot caused by the fungus *Thielaviopsis paradoxa* commonly occurs in wet weather on all types of planting materials especially crowns, which have not been properly cured. The organism also enters the fruit through injuries caused by careless handling and causes soft rot or water blister in the fruit. There is no effective cure for this disease, but prevention is possible by the use of properly cured planting materials and provision of efficient drainage.

PROCESSING

On arrival at the cannery the fruits pass on conveyors to the "Ginaca" machines which at one stroke remove the skin, ends and cores of the fruit. The skins and cores are conveyed to presses which extract the juice for canning after removal of the solids by centrifuging, while the cylinders of flesh pass to the trimming tables where they are inspected and sent to the automatic slicers. The slices are then carefully sorted into cans by packers who wear rubber gloves to protect their hands against corrosive action of the pineapple enzyme. The cans are fed to automatic syrupers which add the requisite amount of syrup and are then conveyed to the exhaust boxes and seaming machines which double seam the top at more than 100 per minute. The sealed cans are taken to the cookers where they are heat treated in agitating sterilizers for about 15–20 minutes and then passed through coolers to prevent over-cooking of the fruit. The tins are stacked in a cool chamber for some time and then labelled by automatic labelling machines. The crushed residue of skins and cores is dehydrated in a rotary drier and used as pineapple bran for feeding livestock, but it is not rich in protein. It is also made into fibre board or used as a mulch in the pineapple fields. Other by-products from waste juice are citric acid, and sugar which is used for making syrup.

The frozen pineapple pack is a new line which is fast becoming popular in England and America. The flesh is diced or cut into chunks and frozen in large tins containing a mixture of pineapple juice and sugar, the proportions used being 7 lb. pineapple chunk, 6 lb. pineapple juice and 8 lb. sugar. The product retains the original flavour of the fresh pineapple and is shipped under refrigeration.

Citrus Growing in Australia

BY

A. V. RICHARDS

CITRUS fruits are popular in Australia, and are grown on a commercial scale in areas where soil and climatic conditions are favourable for healthy tree growth and high fruit quality. Fruit of the best quality is produced under irrigation in semi-dry sub-tropical areas with less than 20 inches of annual rainfall. But some good fruit is also produced under natural rainfall in the coastal belts. The following are the principal citrus growing areas :—

New South Wales

(*a*) Gosford and Mangrove Mountain district in the coastal belt (under natural rainfall).

(*b*) Paramatta and Windsor in the " Hawkesbury River " district.

(*c*) Yanco, Leeton and Griffith in the Murrumbidgee Irrigation area.

(*d*) Curlwaa and Coumealla on the Murray River.

Victoria

(*a*) Mildura, Cobram, and Murrabit on the Murray River.

(*b*) Wangaratta (under natural rainfall).

(*c*) Metropolitan area round Melbourne (under natural rainfall).

South Australia

(*a*) Renmark, Berri and Waikerie on the Murray River.

Queensland

(*a*) Gayndah district on the Burnett river.

(*b*) Maroochyshire (under natural rainfall).

GOSFORD AND MANGROVE MOUNTAIN DISTRICT

This is one of the largest citrus producing centres in the coastal belt about 50 miles north of Sydney. The citrus orchards are situated in sheltered positions on the valley floors and sides of hills which rise to about 1,000 ft. The hills are covered with virgin timber which makes an effective natural shelter belt for citrus.

The rainfall is fairly well distributed, but in some places on the hills where the soil is of a light sandy type which dries out quickly the growers find it beneficial to provide spray irrigation during the dry spells. The soils on the valley floors are of the heavy loamy type, and are inclined to become too sodden for citrus in wet winters.

Varieties.—The principal citrus varieties grown are the Eureka lemon, Valencia and Washington Navel oranges. In the case of lemons the demand is for summer fruit, the winter crop which is not worth marketing is pulled from the trees and disced into the soil. The Valencia orange is in season from October to January, and the Navel orange from late May to September during the winter period. Being grown under natural rainfall there is a tendency for some trees to produce a second crop in October, but it is of poor quality.

Orchard Practice.—Lemon trees which are unthrifty and on the decline are given a drastic "Skeleton" pruning to rejuvenate them, but it is not always successful. Orange trees do not seem to stand such heavy pruning.

In recent years the practice of keeping poultry in the citrus orchard has been found to be quite effective in improving the health and vigour of the trees. About 100 birds to the acre are given free range, and provided with portable houses containing nests for laying eggs (Fig. I). But the poultry has to be made to pay its own way if the benefit to the orchard is to be economical. Among the advantages claimed for this practice are (*a*) effective control of weeds by the poultry and hence lower cultivation costs, (*b*) improved tree vigour and cropping through the incorporation of poultry manure into the soil in addition to normal fertilizers, and (*c*) better retention of soil moisture in the summer months by effective weed control. Against these are the disadvantages of having to pay special attention to the poultry which cannot be neglected even for a short period, and the risk of increase in scale pests on trees subject to dust near poultry houses. Nevertheless the practice of combining poultry farming with fruit growing has become popular because of the remarkable improvement shown by declining lemon and orange trees which are not too far gone.

Contour Planting.—Another practice which is being recommended and demonstrated by the Horticultural Division is contour planting on the hill slopes. Many of the old orchards are planted in rows running up and down the slope, and very little attention is paid to soil conservation. Growers are beginning to appreciate the value of contour planting although it involves more labour than rectangular or square system of planting.

Disease Control.—Citrus trees growing near old tree stumps on the light sandy soils on Mangrove mountain are often killed by Armillaria fungus (*Armillaria mellea*) which is present on the old tree roots, but in the lower sections where the soil is inclined to be rather heavy and wet the trees are attacked by Phytophthora root rot (*Phytophthora citrophthora*). The fibrous feeding roots are killed, the trees become unthrifty and present a wilted appearance for some time before they die. The treatment for Armillaria

in the early stages is to expose the roots and apply Bordeaux paste to the affected parts after scraping out all dead tissue. Trees which are badly affected are pulled out and the soil disinfected by carbon bisulphide, but for the control of Phytophthora the soil has to be well drained, and this is not practicable in many orchards on heavy soils which are subject to flooding during winter. The disease attacks both rough lemon and sweet orange stocks which are used in this area, but the Trifoliata stock (*Poncirus trifoliata*) has been recently found to be resistant to it.

Exanthema due to copper deficiency is common on Navel orange trees grown on the heavier type of soils. The Valencia orange trees are sprayed regularly with copper sprays such as Bordeaux mixture for the control of Black Spot disease on the fruit and do not therefore develop symptoms of exanthema except in rare cases. Trees affected by exanthema also become chlorotic and show gumming and dieback of the twigs. But the most serious disease in this area is Black Spot caused by the fungus *Phoma citricarpa* (McAlp.) which attacks the citrus fruit as it matures during the summer months and produces ugly lesions on it. Control is by spraying with Bordeaux mixture at different periods from " petal fall " stage to maturity. But Navels which mature during the winter months are hardly attacked by this disease.

Pests.—At one time the Mediterranean fruit fly *Ceratitis capitata* (Wied) was prevalent in this area, but now it has been almost completely ousted by the Queensland fruit fly *Strumeta* (*Chætodacus*) *tryoni* (*Frog*) which is larger and more aggressive in habit. Because of the presence of fruit fly no citrus fruits are allowed to be exported from this area to New Zealand. Spraying with Tartar emetic and sugar, or D. D. T. Nicotine sulphate and sugar is recommended, but is not altogether effective. The pest appears in summer and attacks grapefruit badly, but in the case of oranges only the fully ripe Valencia is attacked late in December. The bronze orange bug *Rhoecocoris sulciventris* (Staul) is another pest which attacks young citrus shoots. It is controlled by the assassin bug which feeds on it, but trials are being carried out with systemic sprays which unlike D. D. T. do not kill beneficial predators.

Grading and Packing

The Sungold Rural Co-operative Packing House at Gosford handles much of the fruit produced in that area. The fruit passes over a conveyor belt into a warm solution of sodium silicate maintained at a temperature of about 100°F in a tank. This solution helps to loosen the dust on the fruit which then passes over revolving brushes sprayed from above with warm water to remove dirt and any sooty mould on it. The fruit then goes into a borax bath containing about 4 per cent. of borax at a temperatue of 110°F. The borax treatment is to prevent the development of moulds on the fruit, but if the solution is too strong shrivelling takes place, and the borax crystallises as a white bloom on the fruit and spoils its appearance. After treatment

with borax the fruit passes over revolving rollers to remove excess of borax solution, and then goes into a Brytene wax and borax bath which helps to makes the fruit glossy and improve its keeping quality. From this it passes over revolving rollers into a hot air chamber to dry, and then goes on a conveyor to be sorted into plain grade and standard grade fruit. The plain grade consists of fruit showing slight blemishes caused by Black Spot, melanose, &c. The standard grade fruit is sorted according to size, and all rejected fruit is sent on a separate conveyor to the cull bin. Each grower's fruit is packed separately and despatched to his Agent at the Sydney market. The boxes carry attractive labels giving the name of the packing house, names of the growers and agent, the number of fruits per box and the name of the variety.

HAWKESBURY RIVER DISTRICT

Paramatta and Windsor in "Hawkesbury river" districts were some of of the chief citrus producing centres in the early days, but with frequent flooding and water-logging in wet winters many citrus trees have been killed by Phytophthora root rot. The disease has been so severe owing to flooding that even leaves and fruit hanging close to the ground are affected by brown rot which has a characteristic smell. In one orchard only the few Navel trees on trifoliate orange stock remain healthy, while those nearby on rough lemon stock, which were once healthy, have now declined badly along with all the mandarines on rough lemon stock. But even trees on trifoliate orange stock, if subject to frequent flooding, are attacked by Phytophthora gummosis on the main orange stem.

Armillaria is another disease which is troublesome on sandy soils, the fungus comes with the debris brought by floods.

One of the most serious pests on heavier type of soils in this area is the citrus root eating weevil, which attacks roots of trees in weak condition. The weevils come out of the soil late in spring and go up the trees to lay eggs. An effective control method is to apply sticky band of Ostico with D. D. T. on the shady part of the trunk.

Owing to scarcity of labour citrus fruits not meant for export are not clipped but pulled and thrown into trucks driven between the rows of trees in the orchards. The fruit is then sent with the least delay to the nearby markets in Sydney for sale locally.

The sweet oranges grown in this area are Navels and Valencia. Navels flower slightly earlier in the spring than Valencia, and the fruits mature from about late April to August, but the Valencia ripens late in September and may last till about January. Both varieties mature a month or so later on the hills.

MURRUMBIDGEE IRRIGATION AREA

At one time about a third of the citrus produced in New South Wales used to come from the Murrumbidgee Irrigation Area, but in recent years with the occurrence of wet winters many trees have become affected by Phytophthora root rot, and production appears to have declined.

The total area under horticultural crops is about 20,755 acres, of which 6,588 acres are under citrus, 8,946 acres under deciduous fruits such as apricots, peaches, pears, &c., and 5,221 acres under grape vine. About 25,000 acres are under rice which is grown in rotation with wheat and pasture once in four years or so. The average size of the horticultural holdings is about 25 acres, and of the large area farms where rice is grown 500 acres, but a maximum of only 80 acres is allowed to be planted under rice on each farm each year.

Water for irrigation is stored above Burrinjuck dam on the Murrumbidgee river 240 miles up stream from Berambed where it is diverted into the main irrigation canal. Most of the water is stored during winter and early spring, and released for irrigation from September to April inclusive. The main canal runs for nearly 100 miles from the off-take at Berembed to the furthest point in the irrigation area beyond Griffith. The first point where water is drawn from the main channel into the reticulated system of field channels is at Yanco about 40 miles from the off-take at Berembed. There are in the irrigation area about 840 miles of canals, 810 miles of drainage channels, and 980 miles of roads.

In the horticultural holdings the grower is entitled to a water right of about an acre foot per acre for which he pays at the rate of 10 shillings (Rs. 5.25) per acre foot, and for any water used in excess of this at 15 shillings per acre foot. The water right in the large area farms is about an acre foot for 3 to 5 acres or so, and the charge is 5 shillings per acre foot initially, and 9 shillings per acre foot for any excess water.

Climate and Soil.—The climate of the area is somewhat of the Mediterranean type with an annual rainfall of about 15 inches. The winter rainfall is the most reliable ; the summer rains occur as spasmodic thunderstorms. But the rainfall in any one month seldom exceeds 2·5 inches or so. Frosts may occur in winter making it necessary to burn oil in pots between the rows of trees to prevent frost injury.

The soils of the Murrumbidgee Irrigation Area are highly variable and are grouped as follows :—

1. Soils of the flood plains—Alluvial origin.
2. Soils of the hill slopes—Colluvial origin.
3. Wind blown soils—Aeolian origin.
4. Soils of mixed origin.

The soils of the aeolian origin, which are best suited for citrus consist of sandy material piled 6 feet or more on the original surface of the plain, or deposited in old depressions. But most of the surface soils in the area are also believed to have been partly resorted by wind action.

The large area farms are on the heavier type of soil well away from the horticultural holdings which for the most part are on the lighter soil types. But the sandy alluvial fan below the clay layer allows lateral seepage, and as a result of over irrigation in the past the water table has risen alarmingly high to within a few feet of the surface in certain sections causing serious tree decline in horticultural holdings. Recurring wet winters have aggravated the problem, and many citrus orchards have gone out of production within a very short period.

In order to lower the water table experimental bore holes have been sunk to a depth of 20 to 30 feet in a few places, and water is pumped out by electric turbine pumps into surface drains. The water contains salt in concentration of 40 parts per 100,000 parts of water and is unfit for use in irrigation channels, since the irrigation water is very pure with a salt concentration of only about 20 parts per million or so.

Varieties.—The principal citrus fruits grown in the Murrumbidgee Irrigation Area are lemons and oranges. The orange varieties consist of Washington Navel and Valencia late. The Navels flower slightly earlier than Valencia in spring, and are in season in late autumn and winter, but Valencia mature only during the late spring and summer of the following year.

Grapefruit which was popular during the war when American troops were stationed in Australia is now grown only on a limited scale because of the poor demand for it.

Rootstocks.—Both rough lemon and sweet orange were used extensively in the early days, the former for the light sandy soils and the latter for the loamy types, but the occurrence of the so called "perched" water tables even in the lighter type of soils during wet winters has resulted in heavy incidence of Phytophthora root rot to which both varieties are susceptible. Under normal conditions the citrus tree is apparently able to produce more fibrous roots than those destroyed by the Phytophthora organism present in the soil, but wet soil conditions caused by over irrigation, excessive rainfall, or poor drainage favour the development of the fungus, and the balance is upset making it difficult for the tree to replace the diseased fibrous feeding roots. The effect is noticeable during the following summer when the trees present an unhealthy wilted appearance. Dr. Lilian Fraser (1950), Plant Pathologist of the New South Wales Department of Agriculture, has shown by inoculation experiments that the trifoliata orange is highly resistant to Phytophthora root rot, but even so it will not stand prolonged water logging. Fruit quality is very high on this stock, and the storage life is longer than that of fruit produced on other stocks.

The following are the main disadvantages :—

(*a*) As trifoliata roots do not stand exposure the budgrafted plants have to be planted in the field with the minimum of delay and carefully nursed. Plants in which the roots have been allowed to dry even for a short while take long to make growth in the field, and may even die.

(*b*) Being less drought resistant than rough lemon the trifoliata orange stock does not grow well on light sandy soils which are liable to dry out.

(*c*) Washington Navel orange and grapefruit more often exhibit unhealthy dwarfing on trifoliata orange stock than Valencia orange, but it has been shown by Dr. Lilian Fraser that this so called incompatibility is due to the presence of the scaly butt virus in the scion budwood. Plants raised from budwood of healthy virus free trees of Washington Navel or Valencia on trifoliata stock make normal healthy growth and do not develop scaly butt on the trifoliata stock. Those in which stock over-growth appears early in the nursery are less likely to develop scaly butt than those with a more uniform budunion, and this characteristic is used in the selection of planting material. But there is the danger of the virus being carried by an insect vector although none has been recorded so far. Nearly all the new plantings on loamy soils have been made with plants on trifoliata stock and they show great promise.

Irrigation.—Spray irrigation which involves high capital expenditure of over £100 per acre on pumps, piping, &c., is practised on permeable light sandy soils or on undulating land. There are portable spray equipments and fixed overhead types which throw a spray in a circle.

Furrow irrigation is practised on land which has been graded to ensure an even application of water. Water is allowed to flow along 3 to 4 broad shallow furrows running between the drip of the trees in the rows. A soil auger is used between irrigations to determine whether a dry soil condition is being approached in the feeding root zone. Water is applied before the trees begin to wilt. Irrigation is used to supplement the natural rainfall, and the quantity applied each year varies according to it and the nature of the soil. About 5 to 6 acre inches of irrigation water per year are applied 3 or 4 times during the summer in October, December and February with a late watering if the autumn is dry, but for 15 to 20 year old trees on sandy soils 8 to 12 acre inches may be given in three or four applications. The tendency in the past has been to over-irrigate, and this practice is now discouraged because of the incidence of Phytophthora root rot. Moreover injurious salts are likely to be brought to the surface by capillary action if the water penetrates to great depths.

Drainage.—A net work of surface drains is provided to carry away surplus water from the horticultural holdings. In many cases the soils are not sufficiently permeable to enable under ground tile drains to be used as in Mildura and Renmark, and the initial costs are high.

Cultivation.—The normal routine practice has been to clean cultivate in summer, and grow a green manure crop of field beans or vetches with the rains in winter for discing in spring, but continuous summer clean cultivation tends to destroy organic matter and soil structure, and injure the feeding citrus roots which are generally found at shallow depths. The alternatives to summer clean cultivation which are being tried out are—

(*a*) Reduced summer cultivation.

(*b*) Cultivating only alternate strips.

(*c*) Sod culture, using grass and legumes like Dutch white clover which are sown periodically.

In some private orchards at Griffith lemon and orange trees show remarkably healthy growth under sod culture (Fig. 2) but the sod contains a high proportion of legumes such as Dutch white clover and Burmedic or trefoil, and is mown regularly before the grass runs to seed. But in the sod culture plots in the citrus trial at the Commonwealth Irrigation Research Station, Griffith, the trees show chlorosis and other symptoms of marked nitrogen deficiency. The best growth is shown by trees in the plots sprayed with oil to suppress weed growth.

Manuring.—Citrus trees in the Murrumbidgee Irrigation Area show little response to potash and phosphate, but nitrogen has a marked effect on tree growth and yields. The fertilizer recommendation is 8 lb. of sulphate of ammonia per tree in three dressings of which the first one of 4 lb. is given in early August, the second of 2 lb. in November, and the third of 2 lb. in January. The initial heavy dressing in early August is to promote flowering and good fruit setting. Zinc spray is applied to the foliage as a routine practice once a year to correct mottle leaf condition.

Packing and Grading.—Most growers pick, grade and pack their own fruit for despatch to their commission agents in the large markets at Sydney and Melbourne. Picking is often done by the grower himself and his family with the assistance of some casual labour during the peak of the season. But labour is very scarce and expensive nowadays, and most of the work has to be done by the grower himself. So much so he has become mechanically minded, and has improvised various labour saving gadgets in his workshop, which is a characteristic feature of nearly every horticultural holding. The fruit is generally not washed but brushed mechanically between revolving brushes and graded according to size. Some fruit is sent to the co-operative cannery at Leeton which puts out the famous "Leetona" brand of canned products. Here it is peeled by hand after treatment with hot water to

facilitate peeling, sprayed with hot lye to remove the albido, then washed, sliced into about 3 circular slices and put into cans ; 60 per cent. sugar syrup is then added and the cans exhausted in a steam chamber, sealed mechanically, cooked and stored in a cool place. The canned orange slice which is good for use in fruit salad is a new line which is being put on the United Kingdom market under contract. It provides an outlet for surplus Valencia oranges which have been held long on the trees. The small sized culls are used for making cordials and canned orange juice.

Pests and Diseases.—Red scale *Aonidiella aurantii* (Mask) is the major pest and causes yellowing and defoliation of the foliage and blemishes on the fruit. The control is by spraying with white oil or fumigation with hydrocyanic acid gas. For fumigation each tree is covered at night with a tent under which sulphuric acid diluted with water is allowed to act on sodium or potssium cyanide to produce the gas. No fumigation is done at day time. Spraying is done during February and March, but if the infestation is severe fumigation is done in addition to spraying.

There is no black spot here, but Septoria spot caused by the fungus *Septoria depressa* affects the fruit producing numerous dark brown sunken spots on the rind. It is controlled by application of Bordeaux mixture (2—$2\frac{1}{2}$—100) with $\frac{1}{2}$ gallon white oil in mid-March. But the major disease which has been responsible for large scale tree decline is Phytophthora root rot, control of which is largely dependent on environmental factors. The collar rot or gummosis phase of this fungus is not so common here as in the coastal area.

MURRAY RIVER SETTLEMENTS

Mildura

Mildura together with Merbein and Redcliffs is on the Victorian side of river Murray within a few miles of Curlwaa and Coumealla which are comparatively new soldier settlements on the New South Wales side. They are in an area of low rainfall of about 10 to 12 inches per year with high summer temperatures ranging to as much as 110°F and very cold winters. The irrigation settlement at Mildura was established by Chaffey brothers from Canada. They were men of great courage and foresight who had established similar settlements in California. Despite initial failures they were successful in establishing a flourishing irrigation settlement at Mildura. The original wood burning steam engine pump made in England by Trangee Engineering Firm according to design prepared by Chaffey, and installed in 1888 is still in use lifting water from the Murray river to a height of 20 ft. from which it is again lifted twice by two pumps. A coal burning engine pump is now in use at Redcliffs, and electric power is also generated there for working turbine pumps some distance away. Irrigation water costs more here than in the Murrumbidgee Irrigation Area because of the high costs of pumping from the river.

Soils for Citrus.—The best soils for citrus in this area are the well drained sand ridges carrying a good stand of Murray pine (*Callitris sp.*) on certain sections on either side of the river Murray. On other soils the trees tend to be short lived in spite of efficient underground tile drainage. In some sections boron toxicity is pronounced.

Varieties.—The main citrus varieties are Valencia and Washington Navel oranges with lemons second in importance. Some grape fruit of high quality, and mandarins are also grown. An improved strain of Valencia orange called " Newton's late-hanging Valencia ", which produces smooth skinned fruit of excellent quality and flavour, and holds it long on the tree in good condition, is in great demand for planting. It originated in a private orchard as a budsport like the Leng's early Navel, which is vigorous and produces fruit of high quality very early in the season.

Rootstocks.—In the early days extensive plantings were made on sour orange stock because of its resistance to Phytophthora root rot and gummosis, but many trees on this stock have died in recent years owing to a virus which affects it below the budunion and which is carried by an insect *Aphis citricidus.* This budunion decline is in many respects not unlike the Tristeza disease of Brazil and the Quick Decline of California both of which affect citrus on sour orange stock. Over 8 million trees are estimated to have been killed in Brazil, and the disease is a potential threat to citrus on sour orange in other parts of the world. Fortunately for New South Wales no extensive plantings on sour orange were made, since early attempts to grow citrus on this stock were a failure. Many trees on sour orange stock die almost overnight when affected by this virus (Fig. 3) but some may show slow decline in the orchard. (McAlpin 1948).

The most popular stock now is sweet orange, but rough lemon is used on very sandy soil types. Interest is also being shown in the trifoliata stock for the heavier type of soils.

Pests and Diseases.—There is no fruit fly in this area. The major pest is the red scale which with yellow scale *Aonidiella citrina* (coq.) causes much damage in neglected orchards. Control is by spraying and fumigation. The citrus white fly *Aleuroplatus citri* has been recorded recently in Curlwaa. It is associated with fumigene or sooty mould which spoils the appearance of the fruit. It is easily controlled by spraying.

Cobram and Murrabit

Citrus soils in Cobram area are similar to those at Mildura, but at Murrabit citrus is planted on relatively heavy clay soils. The trees grown at Murrabit have characteristic dark green foliage, and are comparatively small. The earlier plantings on clay soils died out through Phytophthora root rot within about 10 years. But trees planted on a mixture of river sand and clay

overlying 14 feet or so of deep sand have an economic life of about 20 to 25 years. The fruits mature later and retain flavour longer than at Mildura, but they are inclined to be coarse. Some have peculiar reddish markings on the rind.

Wangaratta

The rainfall is fairly well distributed and enables citrus to be grown without irrigation at low cost. But the soils consist of coarse acidic material of low fertility derived from decomposed granite, and as a result the fruit produced is of poor quality and of unattractive light orange colour. Some of the oldest seedling sweet orange trees in the State are still growing here in spite of neglect and heavy red scale infestations. They are believed to be over 90 years old and are of the Paramatta type. Plants raised from seed of these trees have been used in the rootstock trials.

Metropolitan Area—Melbourne

Lemon is the chief citrus fruit grown in this area under rainfed conditions to supply the local market. It is propagated on rough lemon and sweet orange stock. On the trifoliata stock growth is variable and some trees become affected by scaly butt and remain stunted.

Renmark, Berri and Waikerie

The soil and climatic conditions here are similar to those at Mildura, but in the recently established soldier settlements at Cooltong and Loxton citrus is planted only on well drained light sandy soils which are best suited to it, and is spray irrigated. The Cooltong settlement is about 1,000 acres in extent of which nearly 300 acres are under citrus. Each holding averages 20 acres, and the settler is provided with a house costing £2,000. The Loxton settlement started in July 1948 is larger and has about 900 acres under citrus. Water for irrigation is pumped from the Murray river by electric turbine pumps.

At Waikerie, where the soil is only about 2 feet deep overlying lime stone and clay band, no tile drains are provided, but a hole 4 feet radius is sunk to a depth of 20 feet, and from there a 4-in bore is put down to a depth of 80 to 100 feet in drift sand or lime stone having porous honey comb structure. The water drains off into the hole and is believed to find its way eventually into the river bed. An efficient drainage hole is able to draw water from a radius of 11 chains. The holes cost from £100 to £150. This type of drainage is unique and is found only in Waikerie.

Gayndah District—Queensland

The best citrus fruits produced in Queensland come from Gayndah district where they are grown under irrigation on alluvial soils of light texture on the banks of the Burnett river which some 25 years ago were overrun with

prickly pear. The soils have good natural drainage. The annual rainfall is about 25 inches, but the distribution is so erratic that in most years a dry spring is experienced. Frosts are generally mild and do not necessitate orchard heating. Water is pumped direct from the river by each grower, and is applied by means of portable spray lines or fixed overhead sprinklers.

Varieties.—The Ellendale mandarin which originated in the Howard district, probably as a nuceller seedling budsport, grows to perfection here producing large attractive smooth skinned fruits of excellent quality and flavour. Its main defects are the tendency for the branches to split at the crotch and for the rind to crack at the bottom end of the fruit. The trees grow well on sweet orange stock, but on rough lemon they develop chlorotic symptoms which are suggestive of virus infection. The Beauty of Glen Retreat mandarin also grows equally well. Of the other citrus varieties lemons and Navel orange of high quality are produced, but the mid-season Joppa variety and the late Valencia are grown only on limited scale because of the demand for the early varieties.

Rootstocks.—Sweet orange is in favour as a rootstock although on very light soils rough lemon is used. Phytophthora root rot being not a serious problem here on light sandy soils little interest is shown in the resistant trifoliate stocks on which mandarins generally produce fruits of the very best quality. Emperor mandarin has become popular as a rootstock for Beauty of Glen Retreat mandarin.

Cultivation.—Clean cultivation was practised throughout the year in the past, but it is now recognized that it rapidly depletes the soil organic matter, destroys soil structure, and exposes the soil to erosion. The recommended practice is to do minimum of cultivation during the winter months and grow green manure crops in early spring and summer. Green manure crops are not grown in winter because they interfere with harvesting.

Pruning.—Citrus trees are given more drastic pruning in Queensland than in the other states because of the tendency of the trees to grow large in the more subtropical climate. The pruning is done in winter after the fruit is harvested and before blossoms appear. Hardly any summer pruning is practised. The main reasons for pruning are—

(*a*) to keep the trees within manageable size and shape to facilitate cultural, spraying and harvesting operations.

(*b*) to maintain a continuous supply of new wood to produce fruit of high quality.

The most drastic pruning is given to Beauty of Glen Retreat mandarin which has a tendency to overbear. Hand thinning of the crop is always necessary with this variety to produce fruits of good size and quality. Consequently very heavy pruning is practised in winter and many of the buds which would produce fruit are removed with the prunings.

5——J. N. B 23083 (1/53)

The upright growth of the Emperor mandarin is also checked by cutting back the top and shortening the laterals, but the Ellendale mandarin is only lightly pruned. Oranges and grapefruit are pruned more lightly than mandarins.

Pests and Diseases.—Fruit fly is not so common here as in the wet coastal districts. The fruit piercing moth *Othreis fullonica* is troublesome in certain seasons, and there is no effective method of control except picking them by hand when they alight on the fruit at night to puncture it and suck the juice.

Many citrus trees in Queensland are affected by scaly bark or Psorosis, a virus disease which makes the trees unthrifty. But the most serious disease is "Stem Pitting" which has stopped commercial grapefruit production in Queensland. The trees develop depressions in the trunks and main branches, become unhealthy, and produce small fruits with thick rind and no juice. They do not last more than 10 years.

In the Howard district Emperor mandarins are attacked by Brown Spot which is believed to be a bacterial disease causing blemishes on the fruit and young leaves. No other mandarins are attacked. Spraying trials are being carried out for the control of this disease.

Maroochyshire—Queensland

This was at one time the largest citrus producing area in Queensland, but in recent years many trees have declined very badly owing to excessive clean tillage, wet soil conditions caused by rains, and attack by the citrus gall wasp (*Eurytoma fellis*) and borers. Allowing grass and legumes to grow between tree rows and keeping them mown has resulted in striking improvement in tree growth and yield in some orchards. No irrigation is given as the rainfall is often adequate.

The varieties grown are the early Navels, midseason Joppa and late Valencia. The Ellendale mandarin does not grow so well here as at Gayndah, but Beauty of Glen Retreat is satisfactory.

Lemon and grapefruit are badly attacked by the gall wasp which is a native species. Beauty of Glen Retreat Mandarin is also attacked, but Navel orange is more resistant. Large ugly galls are produced on twigs, thorns, leaf stalks and veins, fruit stalks and even on the fruit itself, and they restrict growth and ruin the appearance of the fruit. There is no effective treatment, but systemic sprays under trial show some promise.

The borer is also very destructive on stems and roots of lemons and other citrus trees.

Tropical North Queensland

Citrus is grown commercially on a very limited area, but most home gardens have few trees which provide local requirements. The fruits do not travel well to distant markets and are not of the same high quality as those produced in the semi-dry sub-tropical areas. Pink disease (*Corticium salmonicolor*) is troublesome in the wet areas and necessitates regular pruning of diseased branches and disinfection of cut ends.

REFERENCE

1. Fraser Lilian *et al* (1950) Stunting and Scaly Butt of Citrus. Science Bulletin No. 70. New South Wales Department of Agriculture.

2. Mc Alpin. D. M. *et al*. "Bud-Union Decline" Disease in Citrus Trees. Journal of Agric. Victoria, Australia 46 (1) Jan. 1948.

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The writer takes this opportunity to express his deep gratitude to the Officers of the Commonwealth and State Departments of Agriculture and the many citrus growers whom he had the pleasure of meeting in Australia for their courtesy and kindness in furnishing much of this information on citrus culture.

Fig. 1.—Poultry in the Citrus Orchards near Gosford, New South Wales

Fig. 2.—Healthy Lemon trees under Sod Culture at Griffith, New South Wales

Fig. 3.—Sudden collapse of Sweet Oranges on Sour Orange stock due to Bud Union Decline at Irymple, near Mildura, Victoria

Seed Dormancy in Rice

BY

M. F. CHANDRARATNA, L. H. FERNANDO, AND C. WATTEGEDERA

PRECISE information on varietal differences in seed dormancy is necessary for the efficient organisation of issues of seed paddy to growers. The exact nature of these varietal differences has, hitherto, been obscure, although it has been generally realized that the dormancy of a variety bears some relation to its flowering duration ; late varieties were believed to possess pronounced dormancy.

Chandraratna (1952) recognized three main factors in the age expression of a rice variety, viz., its minimum flowering duration, its optimum photoperiod and its photoperiod sensitivity, and he showed that a complete characterisation of the flowering response of a variety was possible in terms of these three components. It was evident from a scrutiny of available information that varietal differences in the minimum flowering duration and in the optimum photoperiod were not associated with dormancy differences. The relation of photoperiod sensitivity to seed dormancy warranted detailed investigation.

MATERIAL AND METHODS

Twenty-three varieties were tested for dormancy. Most of the material was indigenous to Ceylon and consisted mainly of pure lines under issue by the Department of Agriculture, Ceylon. Fourteen of the Ceylon strains were period-fixed pure lines with a sowing-to-flowering interval not exceeding three months. The other five Ceylon varieties were date-fixed and were late. The three Burmese pure lines included in the test were early when sown in Ceylon in the *maha* (North-East monsoon season) and exhibited marked sensitivity to the photoperiod. The Indian pure line tested, Ptb 16, was late and highly sensitive.

The germination tests were set down at the Rice Research Station, Batalagoda in March, 1952, immediately after the harvest of the seed, and repeated at weekly intervals till the curve of percentage germination reached its peak. The weekly test of each variety consisted of three replicates ; one hundred seeds sown and maintained moist in an unglazed clay dish constituted a replicate. The air temperature during the tests ranged from a minimum of 21° to a maximum of 32°.

RESULTS

The germination percentages of the twenty-three varieties at weekly intervals after harvest are presented in Table 1 ; the figures are 3-replicate averages of the numbers of seeds germinated after eight days. Extrusion of the radicle was considered evidence of germination.

6—J. N. B 23083 (1/53)

The dormancy of a sample of seed can be assumed to have completely expired only when the rise in percentage germination ceases. The seed left ungerminated when the curve flattens may be considered defective. Seed paddy issued by the Department of Agriculture, Ceylon, carries a guarantee of over 80 per cent. germination, and it was found convenient for purposes of the present investigation to consider the attainment of this figure as marking the expiry of the period of dormancy. The date of harvest provides a measure of the average date of maturity of the sample. The interval between the harvest date and the date of over 80 per cent. germination is the estimate of the period of dormancy of the varieties recorded in Table 1.

The *maha* (North-East monsoon) season has a shorter average length of natural day than the *yala* (South West monsoon) season. The shortest day in *maha* approximated 11·7 hours. The longest day in *yala* is about 12·5 hours. Only period-fixed varieties are grown in both seasons. The growing of date-fixed varieties is restricted to the *maha* season. The last column of the table indicates the degree of sensitivity of the varieties to the photoperiod.

The curves of percentage germination of the varieties, Wanni Dahanala 101, Mawi B-11 and HMC-12 are given in Fig. 1.

DISCUSSION

All the varieties tested except *Wanni Dahanala* 101 show recognizable dormancy. In the group of varieties listed as relatively insensitive to photoperiod, however, the period of dormancy does not appear to exceed six weeks. In the highly sensitive group, on the other hand, the period of dormancy is, in no instance, less than six weeks; indeed, except in *Molagusamba* g-18, dormancy exceeds six weeks. The results presented in Table 1 suggest that the seed dormancy of a variety may be a function of its photoperiod sensitivity. The results obtained by workers in Indonesia are in agreement with this suggestion; the *bulu* varieties possess no dormancy, but the *tjereh* varieties do. The *tjerehs* are appreciably sensitive to the photoperiod, and the *bulus* are conspicuously insensitive.

The survival value of dormancy and of its absence calls for comment. The seed of a sensitive variety which exhibits no dormancy would germinate at a time when the natural photoperiod would inhibit flowering. The possession of dormancy prevents germination in a sensitive variety till favourable photoperiods supervene. On the other hand, dormancy is disadvantageous to an insensitive variety grown in both seasons.

SUMMARY

The results of germination tests conducted at the Rice Research Station, Batalagoda, with twenty-three varieties of rice suggest that seed dormancy is related to photoperiod sensitivity. Dormancy is more marked in the highly sensitive varieties.

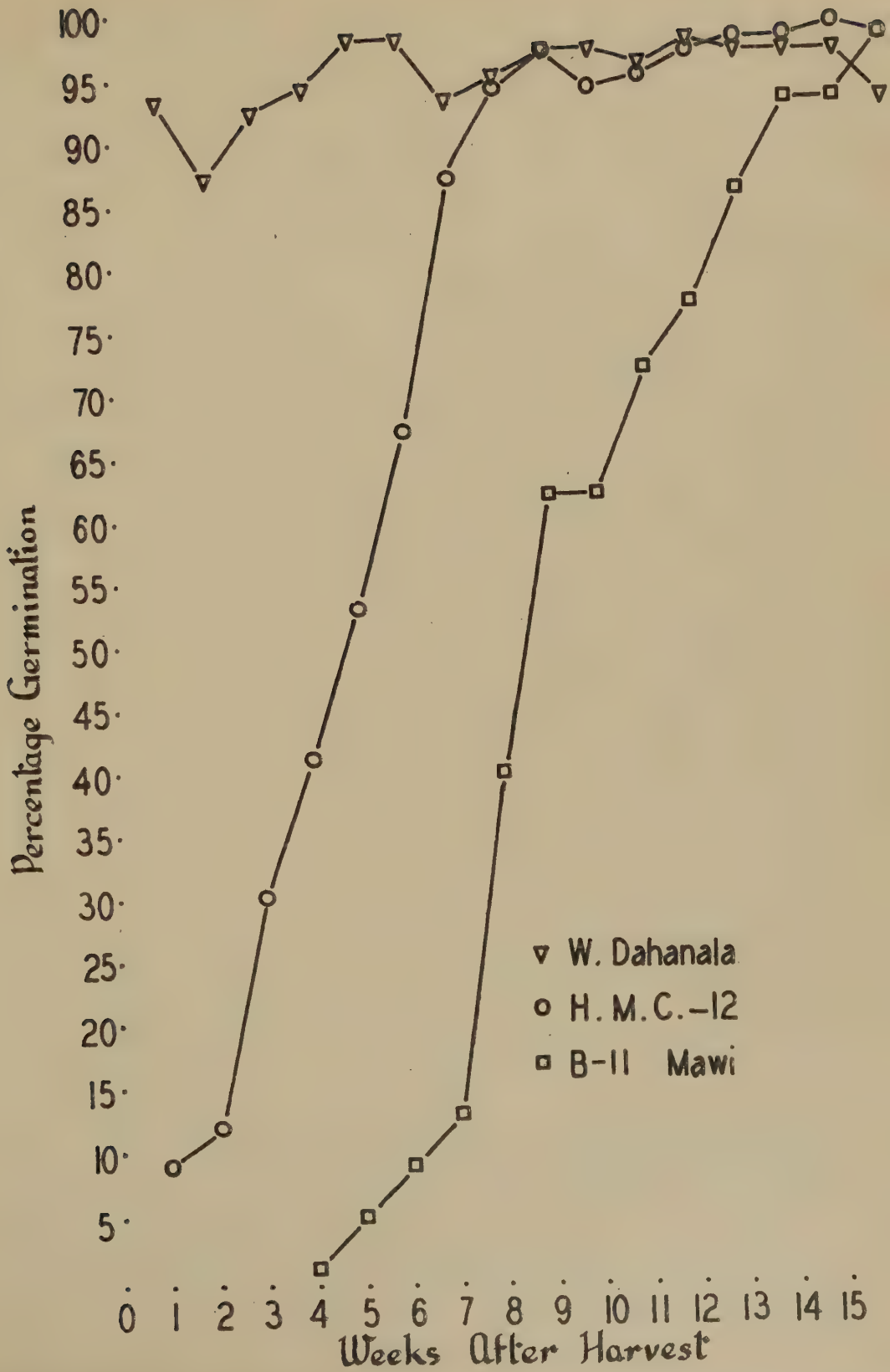
LITERATURE

Chandraratne M. F. "Photoperiod Effects on the Flowering of Tropical Rices" 1952—Trop. Agricst. 108 4–10.

TABLE 1.—Results of Germination Tests

	Country of origin	Name of variety and Index number of selection	Percentage germination at Weekly Intervals— Weeks after harvest																	Estimate of dormancy duration in weeks	Interval from sowing to flowering in months	Season of cultivation	Photoperiod reaction
1.	Ceylon	Kaluheenati 3254	51	68	67	*90*	88	84	97	96	100	96	93	96	96	98	93	97		3	2 –2½	Maha and Yala	Relatively insensitive
2.	Do.	Murunga 137	46	61	*81*	88	94	98	96	97	99	97	96	99	98	95	96	98		2	„	„	„
3.	Do.	Wanni Dahanala 101	*93*	87	92	94	98	98	93	95	97	97	96	98	97	97	97	93		0	„	„	„
4.	Do.	Heenati ICPY-15	—	—	—	—	*93*	93	97	100	98	98	97	99	100	99	97	98		4	2½–3	„	„
5.	Do.	Heenati ICPY-19	—	—	—	—	*84*	95	99	97	95	99	98	96	100	98	94	99		4	„	„	„
6.	Do.	Heenati Hf-9	—	—	—	—	*89*	92	94	92	97	95	94	97	99	97	96	97		4	„	„	„
7.	Do.	Rathkarayal 3753	5	3	18	52	71	*85*	99	100	98	99	100	99	99	99	99	98		5	„	„	„
8.	Do.	Sinnana yan 2208	—	—	—	—	*95*	99	97	97	99	96	99	97	97	99	98	98		4	„	„	„
9.	Do.	Sinnana yan 398	—	36	62	79	*84*	94	95	98	99	100	99	100	99	99	100	98		4	„	„	„
10.	Do.	Sulai 27614	—	—	—	—	79	*87*	93	95	97	96	96	94	98	99	99	98		5	„	„	„
11.	Do.	Oddavalan 2449/20	—	—	—	76	*89*	90	96	95	94	92	99	99	97	99	97	99		4	„	„	„
12.	Do.	Perillanel 26014	74	79	*94*	96	92	96	96	98	98	91	96	97	94	96	97	93		2	„	„	„
13.	Do.	Madael 137	—	—	—	42	75	*94*	88	98	98	99	99	100	98	97	100	96		5	„	„	„
14.	Do.	Vellai Illankalayan 28061	0	0	6	40	73	*81*	89	94	96	98	99	94	95	98	96	96		5	„	„	„
15.	Do.	Mola gusamba g-18	0	3	20	58	74	*87*	95	95	98	99	98	98	99	99	100	99		5	5	Maha only	Highly sensitive
16.	Do.	Podiwi a-8	0	1	3	2	21	22	36	45	75	*87*	69	71	91	92	93	91		12	„	„	„
17.	Do.	Kurulutuduwi b-13	0	6	20	37	55	76	*83*	92	94	98	96	96	97	99	98	98		6	„	„	„
18.	Do.	Mawi B-11	0	0	0	1	5	9	13	40	62	62	72	77	*86*	93	93	98		12	„	„	„
19.	Do.	Panduruwi	—	9	—	18	—	44	—	68	—	*88*	—	89	—	86	—	91		9	5½	„	„
20.	Burma	HMC-12	9	12	30	41	53	67	*87*	94	97	94	95	97	98	98	99	98		6	3	„	„
21.	Do.	HMC-20	26	36	43	64	71	80	*87*	98	93	92	97	91	99	93	91	93		6	3	„	„
22.	Do.	MYAC-104	0	0	1	1	6	23	37	48	78	80	*88*	85	87	96	91	98		10	2½	„	„
23.	India	Ptb-16	0	5	8	21	43	67	*81*	93	99	97	97	98	97	98	98	98		6	5	„	„

The intervals from sowing to flowering in the normal seasons of cultivation in Ceylon, of the varieties under test are included in the above table. The normal seasons of cultivation of these varieties are mentioned in the penultimate column.



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REVIEWS

"Botany of Sugarcane" by C. Van Dillewijn

WALTHUM, MASS. : THE CHRONICA BOTANICA Co.

THE publication of this handbook by the Sugarcane Expert of the Food and Agriculture Organization of the United Nations and one-time Director of the Sugar Experiment Station, Cheribon, is an event of considerable significance in the annals of sugarcane research. Investigational work on this crop has been voluminous and scattered, and although regional accounts of certain aspects of sugarcane work exist, the lack of a satisfactory manual which integrated the experience and the experimental results of various countries has seriously handicapped the research worker. Dr. van Dillewijn's masterly monograph fills this hiatus. Not only does this lucid presentation of existing knowledge of sugarcane make it possible for the research worker to see his problems in perspective, but the careful sorting of the material into sections and sub-sections facilitats reference.

Two broad sections are recognized, viz., (1) Morphology and Anatomy, with chapters on the stem, bud, leaf, inflorenscence and root, and (2) Physiology with chapters covering germination, tillering, growth, vegetative and chemical composition, nutrition, water relations, photosynthesis and respiration. The most striking virtues of the book are the lucidity of thought and clarity of diction which characterize every page. The section on physiology which composes the bulk of the book—274 pages out of 332—is particularly ambitious and stimulating. Chapter 7 on germination discusses the influence of environmental factors, preplanting treatments and the use of growth-regulating substances. Chapter 8 on tillering will interest all workers on grasses. Chapter 9 on Growth discusses the conformity of shoot and root growth to Blackman's Compound Interest Law, Van't Hoff's Rule and other formulae. Chapter 12 on Nutrition deals in detail with the rôle of N, P,K, calcium, and trace elements. Chapter 13 covers all aspects of water relations of sugarcane and presents evidence of the plant's curious capacity for absorbing large quantities of water aerially. Chapter 14 on photosynthesis treats exhaustively with sucrose synthesis, translocation, storage and inversion. The only chapters that are somewhat circumscribed in scope are Chapters 10 and 15 on Vegetative Composition and Respiration.

The author preserves a fine sense of proportion in the handling of an amazing mass of information, and in no instance does his own research obtrude unduly. The approach is factual throughout, speculative discussions are curtailed, and the translations of research results to practice receives full emphasis.

The book should prove valuable not only to those interested in sugarcane, but to workers on related crops. The reviewer finds the book helpful in his investigational work with rice. The systematy, cytogenetics, anthesis and breeding of sugarcane are excluded, but these subjects will, of course, find a place in the completed Handbook of Sugarcane of which the volume under review is the first.

The 229 line drawings and half-tone reproductions are uniformly of excellant quality. A list of these illustrations would prove a useful insertion in the next edition. Errors and misprints are refreshingly scarce, and the pleasing format reflects credit on both author and publisher.

M. F. C.

7——J. N. B 23088 (1/53)

DEPARTMENTAL NOTES

Soil Surveys for Colonization Schemes

BY

S. KANDIAH

ONE of the main development functions undertaken by Government at present is to settle landless villagers by opening up colonization schemes in areas which have hitherto remained in jungle or in an undeveloped state. The primary step in the process of land development for colonization of any particular area is to call for a report based on the soil survey of the area by the Chemist of the Department of Agriculture. The soil survey undertaken for such a purpose is not often of a detailed kind but is in the nature of a reconnaisance survey, the primary object being to determine in the first instance if the land is suitable for development. The soils in the area are classified according to texture into various types, and their fertility status is assessed. The presence of any unfavourable factor such as improper drainage, soil salinity, alkalinity or excessive acidity is also investigated. When an area is found satisfactory a soil map is prepared indicating roughly the disposition of the various soil types present and recommendations are made as to the crops best suited for cultivation and the measures to be adopted for maintaining soil fertility and correcting any unfavourable factor where such exists.

The nature of the vegetation growing is to a large degree governed by the soil conditions obtaining in the area and could often given an indication as to the texture, structure, depth and drainage conditions of the soil. For example thorny shrubs are invariably associated with ill drained soils of a heavy texture, exhibiting heavy mottling and scrub jungle with shallow light textured or gravelly types of low water retention. Where the soil is deep and well drained the vegetation is high forest. The presence of such high forest is not an infallible index of the high fertility of the soils, as one would be inclined to assume, as in the course of the various soil surveys it has been observed on several occasions that some of them belie these expectations and, in fact, being composed of single grain sands are often of very low agricultural value. It was to guard against such unwarranted assumptions that Vaegler warned, "In nothing must the agricultural pioneer seeking land be more cautious than in estimating the richness of soil by vegetation alone." The question how then such a poor soil carries such luxuriant vegetation would naturally arise and Raman furnishes an answer. "Most tropical soils are deficient in plant nutrients and are in great need of manures. The foliage which falls continually throughout the year, decay rapidly and the liberated plant nutrients circulating very rapidly suffice for the great luxuriance of the Tropical forest. On the whole Tropical forest works with a small capital of nutrients and a rapid turnover."

Most of the soil surveys carried out has been of lands for development under paddy. Jacks bases the rating of paddy soils on the clay contents and regards those with 25–65 per cent. clay and 20–60 per cent. silt as first class paddy lands, those with 15–30 and 25–40 per cent. respectively of these constituents as second class while this third class constitutes those with 5–20 per cent. of each of these fractions. It is rather unfortunate that he does not give the profile characteristics of these groups of soils. The experience in Ceylon has been that paddy does not yield high in heavy clay soils with deep subsoils of a similar texture, but remarkably high yields have been found to be associated with soils of a clay loam or heavy loam of limited depth overlying a porous subsoil of either decomposing rock, gravel or sand, making way for efficient subsoil drainage. A sandy soil with a subsoil of a clayey nature, which impedes drainage, is found to be the lowest in yield. On the other hand sandy loams or even sandy soils, provided the duty of water is not excessively high, produce surprisingly high yields when they are properly manured with the inclusion of bulky organics, such as compost, cattle manure or green manure. High yields in fact could be expected under these conditions, because the physical condition of the soil is ideal for plant growth and whatever manure is applied becomes readily available to plants, as very little fixation of fertilizing constituents takes place to make them unavailable. Heavier types of soils, on the other hand, even when they are not intrinsically so high in plant nutrient status, do not often respond to the same extent to the application of fertilizers, owing to fixation into unavailable forms of a portion of the phosphates or potash applied.

In recommending an area as being fit for development consideration should therefore be given to (1) the natural fertility of the soil, (2) the nature of the crop to be grown, (3) pressure for land in that region, (4) whether it is for peasant settlement, for colonization by middle class or for capitalistic undertaking. For paddy, the land should not require a high duty of water, while for high land crops the soil should in addition be deep and free from impervious layers which would cause obstruction to root development. Close to populated areas where pressure for land is generally high, even comparatively poor lands may have to be developed to relieve the pressure. On the other hand in remote areas where transport is difficult, only lands capable of producing heavy yields should be recommended. An area with a soil of heavy texture capable of fairly satisfactory yields over considerably long periods without much manuring will be preferable for peasant settlement to a light textured soil which give high yields only if it is systematically manured.

The method of cultivation adopted should be so designed as to conserve the fertility of the soil and help to produce at the same time the maximum yield possible from the land. From what follows it will be seen that the same method of cultivation will not be applicable under the variable conditions obtaining in Ceylon. In the wet zone as a result of laterization that is taking place, the soils are acid in reaction and the clay is not highly dispersible. When erosion takes place, on account of the prevailing topography and the nature of the clay, the soil itself moves in a body. In the dry zone where

conditions are generally the reverse of those found in the wet zone, the clay particles disperse and under the topographical conditions obtaining here, a preferential movement of the clay down the slope or into the lower horizons takes place. The result of these is reflected in the marked variation one could observe in the colour and in the texture of the soils of the dry zone catenas, the soil in the crest being reddish in colour with a higher percentage of clay and becoming brown and then dark with a progressive reduction in the clay content as it reaches the base of the slopes. The clay thus carried away is no doubt deposited still further down where the flood waters accumulate and deposit the load of clay. The presence of the dark soils of the heaviest texture in Ceylon found round about Ambalantota in the South, Murungan in the West, Tambalagaman or Allai in the East could thus be explained. While there may not be much harm in adopting the traditional method of puddling the soils in the wet zone, the treatment to be adopted in the dry zone necessarily needs modification. The clay content of most of these soils is already low and every attempt should be made to conserve this vital constituent, the importance of which is too well known to be discussed here. When these soils are puddled, the clay readily disperses and remains in suspension for a considerably long period and unless sufficient time is given for it to settle down, it is liable to be carried away in the drainage water, as it invariably happens, causing an impoverishment of the soil. In practically every one of the soil surveys carried out in the dry zone, the sandy nature of the cultivated blocks of paddy soils in contrast to the much heavier types found in the adjoining jungle lands would compel one to pause and consider how enormous is the damage done to these soils by the traditional method of puddling these soils and letting off the water before the clay could settle down. Since it is highly improbable that this damage could satisfactorily be eliminated, the possibility of replacing it by a more rational system should receive careful consideration. The adoption of the practice of dry sowing "kekulang" would appear to offer possibilities and merits investigation. This has certain other advantages as well. The main factor militating against its adoption would be the control of weeds. It is possible that the use of weedicides available today in various formations would afford an easy means of weed control and facilitate the adoption of dry sowing eliminating at least in the dry zone the puddling of paddy soils.

Cultivation of Buckwheat on Up-Country Patanas

BY

A. V. ANKER LADEFOGED

EXPERIMENTS and field-trials carried out at Bopatalawa Cattle Farm during the last one year have shown that Buckwheat (Fagopyrum-sagittatum) grows very well on up-country patanas, and that it is an excellent crop for soil improvement on these lands.

Experience in the past shows, that improved pastures, with both grasses and legumes, cannot be established with success on virgin patana land, and that it is possible only after the soil is brought to good physical condition by growing a rotation of different crops. One of the main difficulties, however, in adopting this practice has been the non-availability of a crop able to provide a good cover and to produce a reasonable yield on newly opened patana land. Buckwheat has now proved very useful as a first crop on virgin patana and a big problem involved in pasture establishment and crop production on this type of land has therefore now been satisfactorily solved.

In November, 1951, a small quantity of Buckwheat seed was obtained from Denmark and subsequently, during the same month, two half-acre blocks of fairly steep patana (1 : 25) were planted with this seed. The land was manured prior to planting as follows : $\frac{1}{2}$ ton lime, 1 cwt. basic slag, 1 cwt. cynamide and $\frac{1}{2}$ cwt. of muriate of potash per acre. The crops of Buckwheat were ready for harvest $3\frac{1}{2}$ months later and gave the following amounts of seed. Block 1—1,554 lb. per acre and Block 2—900 lb. per acre. On block 2, the seed rate had been too heavy and an excess vegetative growth was the result, while on block 1, although the same seed rate had been used, the vegetative growth was less due to a natural thinning out by a heavy wash, which took place the day the block was sown. The plants reached 3 to $3\frac{1}{2}$ feet in height and made an excellent cover smothering almost all weeds.

Since then Buckwheat has been grown on a much larger scale and the results have been very satisfactory when taking the quality of land used into consideration. At present more than 50 acres at Bopatalawa and about 15 acres at Ambawela are under Buckwheat. From the results we have got in hand during 9 months field cultivation the following conclusions can be made :—

(1) Buckwheat tolerates acidity of soils to a large extent ; however, if high yields are to be obtained a slight dressing of lime is recommended—($\frac{1}{2}$ ton per acre every 2 years may be adopted as a rule).

(2) Buckwheat responds well to application of phosphatic fertilizer and also to some extent to nitrogen and potash fertilizers. Pot-experiments being carried out at present indicate that there is no need to supply any minor elements except in cases where a heavy dressing of lime is applied ;

8—J. N. B 23083 (1/53)

under these circumstances there seems to be a definite need for Manganese. The rate of fertilizer application now adopted is : 1 cwt. basic slag, ½ cwt. cynamide and ½ cwt. muriate of potash per acre.

(3) The seed rate should be between 50 to 60 lb. per acre for grain crops and about 70 lb. per acre if the purpose is a green crop.

(4) The seeds germinate very quickly and the plants appear about 4 days after sowing. The crop is able to check soil erosion completely once the plants are 14 days old (even on steeper areas).

(5) Buckwheat can produce a very good green crop in about 2½ months time from the date of planting. The green crop is readily eaten by cattle and is of fairly high nutritive value. (Care must, however, be taken when feeding green Buckwheat, because, when fed in big quantities to cattle exposed to strong sunlight, it sometimes may cause a kind of skin excema).

(6) The average yield of grain per acre obtained at Bopatalawa is 1,200 lb. The yields have, however, been considerably higher on such fields where a 1st class seed bed could be prepared. The grains are readily eaten by all types of livestock and the feeding value is close to that of oats.

(7) The straw left over from the grain crop provides excellent bedding, but is unpalatable and of low feeding value.

(8) Buckwheat is a hardy crop, which tolerates to a large extent both wet and dry weather conditions. It is, however, very essential that the weather should be dry at the time of harvest, as the seed when matured fall off very easily. The time for harvesting a grain crop is not always easy to decide upon, as all seeds do not mature at once. (Seeds keep on maturing sometimes over a period of three weeks). The day of harvest should therefore be carefully selected.

(9) Buckwheat has been tried also at lowland stations, but although it grows fairly well (to about 2½ ft.) it does not produce much seed.

The explanation as to why Buckwheat is able to produce so well even on virgin patana land, most probably lies in the fact that the plants are very shallow rooted. It has been noted, that after ploughing a patana-grass sward, it takes a long time for this sward to decompose and while the deep rooted crops fail to thrive under such conditions, the shallow rooted Buckwheat does well.

There is a marked difference in the condition of the soil after a Buckwheat crop and the land can then with success be used for other crops. The following rotation is now being used at Bopatalawa :—

(1) (On virgin patana). Buckwheat. Manuring : 1 cwt. basic slag, ½ cwt. cynamide, ½ cwt. muriate of potash.
(2) Lupins mixed with Sunflower. 1 cwt. basic slag, 1 cwt. muriate of potash and ½ cwt. of cynamide.
(3) Radish for feeding. 10 tons cattle manure per acre.
(4) Buckwheat ½ seed rate as nurse crop for pasture (in order to avoid soil erosion).

A dressing of ½ ton lime per acre is given every 2 years.—Finally it may be mentioned that Buckwheat is insect-pollinated and attracts a large number of bees.

Bopats Unit 2.—Buckwheat on partially terraced land with separate riser banks of original Patna Grass preserved

RESEARCH NOTES

Red Polls at Bopatalawa

STUDIES in breed-environment interaction are being conducted in an attempt to assess the relative producing ability and adaptability, under varying climatic conditions, of the many breeds of cattle already imported into Ceylon. Statistical studies of data carefully collected over the past two years, have shown among other things, that the relative performance of the Red Polls and Friesians under similar conditions is such that the probable producing ability of the Friesians exceeds that of the Red Polls by over 50 per cent. on the average. Significant differences have also been found between these two breeds as regards length of lactation.

In the light of these studies, which will be published in greater detail at a later date, the Animal Husbandry Committee has decided to grade up the entire Red Poll herd at Bopatalawa to Friesian. This procedure, which would bring into existence a herd of high-grade Friesians in a few generations, is expected not only to increase the milk yield appreciably, but also to reduce considerably the numerous problems arising on a farm that maintains a multiplicity of breeds.

P. MAHADEVAN.

PROMISING LEGUMES

IN the trials that are in progress with both introduced and uncultivated indigenous legunes, the following two species have recently shown promise of being useful especially as ground covers for tea :—

(a) **Ground cover, non-creeper**

Crotalaria evolvuloides Wight.—This is a local species which has a much branched, prostrate habit. The pinnate somewhat oval leaves are borne on slightly angular hairy stems. The small, yellow flowers appear during January to April and develop hairy, straw coloured ovoid pods, $\frac{1}{2}$ in. long. This legume produces a dense cover not more than about 2-4 in. high.

(b) **Ground cover/bulk producing non-creeper**

Stylosanthes Bojeri Vogel is an introduced species, seed of which was received in 1952 from the C. S. I. R. O. Canberra, Australia, from material originally obtained from Tanganiyaka. It is a vigorous, much branched plant with a low spreading habit. The stems are hairy and covered with yellow bristles. The trifoliate leaves are also hairy and produce creamy yellow flowers in dense terminal heads.

W. R. C. PAUL.

9——J. N. B 23083 (1/53)

MEETINGS

Rubber Research Institute of Ceylon

MINUTES OF THE 115TH MEETING OF THE RUBBER RESEARCH BOARD HELD AT DARTONFIELD AT 2.30 P.M. ON MONDAY, OCTOBER 27, 1952

Present—Mr. W. A.Paterson, J.P. (in the Chair), Mr. W. P. H. Dias, J.P., Mr. W. Herbert de Silva, Mr. R. J. Hartley, Dr. A. W. R. Joachim, M.B.E. (Director of Agriculture), Major Montague Jayawickrema, M.P., Gate Muhandiram Arthur D. S. Jayasinghe, Senator C. F. W. Wickremesinghe and Dr. H. E. Young (Director, R. R. I.).

Mr. R. H. Wickremesinghe, C.C.S. (Controller of Supply and Cadre), had intimated his inability to attend.

Mr. W. Herbert de Silva and Gate Muhandiram Jayasinghe inspected the clearings at Hedigalla and some of the buildings at Dartonfield in the morning in the company of the Director and the Estate Superintendent.

1. BOARD

The Chairman reported that Mr. R. J. Hartley had returned from leave and resumed membership with effect from October 8, 1952, relieving Mr. F. A. Ruck, who had been acting for him. A vote of thanks was passed for Mr. Ruck's services.

2. MINUTES

(*a*) **Confirmation**— Draft minutes of the meeting held on July 31, 1952, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) **Matters arising from the minutes**—

1. *Research Assistants*—Agreed that Mr. M. Nadarajah, B.Sc. (Ceylon), be appointed Research Assistant, Chemical Department, on probation.

2. *Planting material for Smallholders*—The minutes of the Conference with the Department of Agriculture were considered, and the arrangement that clonal seedlings should be supplied by the Department of Agriculture and budded stumps by the Institute was approved.

3. DECISION BY CIRCULATION OF PAPERS

Exchange of Budwood between various Institutions in South-East Asia—It was reported that members had agreed to the proposal made in C. PP. 1690 and 1690A and that the necessary action had been taken.

4. REPORTS AND ACCOUNTS

(*a*) *Research Programme for 1953*—was considered. The initiation of a breeding programme as suggested by the Director was considered to be most important and it was agreed that a local officer with experience of this type of work be appointed to the Botany Department.

(*b*) *Auditor-General's Report and Balance Sheet for 1951*—were approved. Over-expenditure on revenue and capital votes amounting to Rs. 22,132 and Rs. 11,594 respectively were approved and unspent balances of 1951 capital votes amounting to Rs. 259,197 were re-voted for 1952.

(*c*) *Statements of Receipts and Payments for the Quarters ended March 31 and June 30, 1952*—were approved.

(*d*) *Estate Accounts, April to June, 1952*—were tabled.

(*e*) *Draft Estimates for 1953*—Draft estimates providing for income and expenditure as follows were approved :—

		Rs.
Income		1,312,950
Expenditure :	*Rs.*	
Revenue	1,132,372	
Capital	538,950	
		1,671,322
Excess of expenditure over income		358,372

(*f*) *Inventory Report for 1951*—was adopted.

(*g*) *Audit Queries*—Four queries were considered and covering sanction was granted for the payments mentioned therein.

(*h*) *Institution of the Rubber Industry*—Correspondence with the Institution of the Rubber Industry regarding the approval of the R. R. I. of Ceylon as a training centre for the diploma examinations of the Institution was tabled and it was noted that the Institute had been approved for this purpose.

5. EXPERIMENTAL COMMITTEE

Mr. Dias' proposal that the Experimental Committee should meet regularly in future was passed.

6. SMALL HOLDINGS COMMITTEE

Mr. Dias' proposal that the Smallholdings Committee should meet regularly in future was passed.

7. TRAINING OF SUPERINTENDENTS AND ASSISTANT SUPERINTENDENTS

Mr. Dias' proposal that the R. R. I. should take in annually two or three youngsters as creepers for training as Superintendents or Assistant Superintendents of estates was agreed to in principle. It was agreed that a start should be made with two trainees, and the Experimental Committee was asked to go into the matter and report on its practicability and implementation.

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8. TECHNICAL MATTERS

(*a*) *Conference of Scientific Officers of Rubber Research Institutes held at Bogor, Indonesia*—The Chemist's report dealing with the technological aspects of the Conference was approved.

(*b*) *Director's memo on South American Leaf Disease*—was approved.

9. ESTATE ITEMS

(*a*) *School Master*—It was agreed that the Sinhalese School Master at Dartonfield be transferred to Hedigalla to take charge of the school which is being built there.

10. STAFF

(*a*) *S. H. P. O.*—It was reported that Mr. W. I. Pieris, Smallholdings Propaganda Officer, had returned from leave and resumed duties on October 1, 1952.

(*b*) *Assistant Staff*—Changes in Assistant Staff were reported and approved.

(*c*) *Staff Club*—A copy of the rules of the Staff Club was tabled.

11. LONDON ADVISORY COMMITTEE

Minutes of the 56th Meetings of the Committee and the Technical Sub-Committee were tabled In connection with item 3 of the minutes of the Advisory Committee, the Chairman reported the receipt of a letter from the Chairman of the London Advisory Committee supporting the suggestion that the Director should pay a short visit to London to attend the meeting of the Agricultural Sub-Committee to be held on November 25, 1952. It was agreed that the Director should attend this meeting.

12. PUBLICATIONS

The following publications were tabled :—

(1) Report of the Work of The Rubber Research Board in 1951.

(2) Combined 3rd and 4th Quarterly Circulars for 1951.

(3) Advisory Circular No. 34—Tapping Systems.

(4) Advisory Circular No. 35—Notes on Rubber Seedling Nurseries.

(5) Advisory Circular No. 21 (Revised)—The Control of Bark Rot and Canker.

(6) Advisory Circular No. 1 (Revised)—Notes on Budgrafting Procedure.

The meeting then terminated.

Dartonfield,
Agalawatta, November 29, 1952.

C. D. DE FONSEKA,
Secretary-Accountant.

RETURNS, &c.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED AUGUST 31, 1952

Province	Disease	Fresh Cases during the Month	Total number from the beginning of this Calendar Year to August 31, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	40	138	—	—	114	24
	Rabies	—	5	4	1	—	—
Colombo Municipality	Foot-and-mouth	—	200	—	—	200	—
	Rabies	2	31	31	—	—	—
Quarantine Station	Anthrax	40	44	44	—	—	—
	Pleuro-pneumonia	37	242	242	—	—	—
Northern Province	Foot-and-mouth	84	883	2	—	818	63
	Anthrax	—	107	107	—	—	—
	Rabies	2	3	—	3	—	—
	Black quarter	75	216	216	—	—	—
North-Central Province ..	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Anthrax	—	16	16	—	—	—
	Rabies	—	2	—	2	—	—
	Black quarter	68	68	68	—	—	—
Central Province	Mange (cattle)	6	188	11	—	171	6
	Foot-and-mouth	—	471	1	1	469	—
	Rabies	1	3	—	3	—	—
	Piroplasmosis	1	1	—	—	1	—
Province of Sabaragamuwa	Foot-and-mouth	—	428	22	—	406	—
	Rabies	—	6	—	6	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva ..	Rabies	1	4	2	2	—	—
Eastern Province	Foot-and-mouth	57	786	33	—	746	7
	Black quarter	24	42	41	—	1	—
Southern Province ..	Rabies	4	4	—	4	—	—

Department of Agriculture,
Peradeniya, Ceylon,
October 9, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED SEPTEMBER 30, 1952

Province	Disease	Fresh Cases during the Month	Total number from the beginning of this Calendar Year to September 30, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	4	142	—	—	137	5
	Rabies	18	23	4	19	—	—
Colombo Municipality	Foot-and-mouth	—	200	—	—	200	—
	Rabies	7	38	38	—	—	—
Quarantine Station	Anthrax	30	74	74	—	—	—
	Pleuro-pneumonia	22	264	264	—	—	—
Northern Province	Foot-and-mouth	459	1,342	2	—	1,248	92
	Anthrax	—	107	107	—	—	—
	Rabies	—	3	—	3	—	—
	Black quarter	72	288	288	—	—	—
North-Central Province	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Anthrax	—	16	16	—	—	—
	Rabies	—	2	—	2	—	—
	Black quarter	53	121	121	—	—	—
Central Province	Mange (cattle)	26	214	16	—	172	26
	Foot-and-mouth	—	471	1	1	469	—
	Rabies	2	5	—	5	—	—
	Piroplasmosis	1	2	—	—	2	—
Province of Sabaragamuwa	Foot-and-mouth	2	430	22	—	406	2
	Rabies	—	6	—	6	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva	Rabies	1	5	2	3	—	—
Eastern Province	Foot-and-mouth	—	786	33	—	753	—
	Black quarter	4	46	45	—	1	—
Southern Province	Rabies	1	5	—	5	—	—

Department of Agriculture,
Peradeniya, Ceylon,
November 6, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED OCTOBER 31, 1952

Province	Disease	Fresh Cases during the Month	Total number from the beginning of this Calendar Year to October 31, 1952				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	9	151	—	—	145	6
	Rabies	16	39	4	35	—	—
Colombo Municipality	Foot-and-mouth	—	200	—	—	200	—
	Rabies	7	45	45	—	—	—
Quarantine Station	Anthrax	2	76	76	—	—	—
	Pleuro-pneumonia	30	294	294	—	—	—
Northern Province	Foot-and-mouth	130	1,472	2	—	1,396	74
	Anthrax	1	108	108	—	—	—
	Rabies	—	3	—	3	—	—
	Black quarter	—	288	288	—	—	—
North-Central Province ..	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Anthrax	—	16	16	—	—	—
	Rabies	1	3	—	3	—	—
	Black quarter	18	139	139	—	—	—
Central Province	Mange (cattle)	45	259	16	—	198	45
	Foot-and-mouth	—	471	1	1	469	—
	Rabies	5	10	—	10	—	—
	Piroplasmosis	—	2	—	—	2	—
Province of Sabaragamuwa	Foot-and-mouth	—	430	22	—	408	—
	Rabies	2	8	—	8	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva ..	Rabies	—	5	2	3	—	—
Eastern Province	Foot-and-mouth	—	786	33	—	753	—
	Black quarter	—	46	45	—	1	—
Southern Province ..	Rabies	—	5	—	5	—	—

Department of Agriculture,
Peradeniya, Ceylon,
December 10, 1952.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, SEPTEMBER, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No .of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	95·3	+3·6	75·6	+0·5	54	86	4·2	2·56	5	— 1·20
Badulla	87·4	+1·8	63·8	—0·5	60	94	5·2	1·97	8	— 2·52
Batticaloa	89·8	0	76·4	+0·2	71	84	3·7	0·26	2	— 2·13
Colombo	87·4	+2·0	76·8	+0·2	74	86	5·8	8·40	15	+ 1·56
Diyatalawa	78·8	+1·0	59·5	—1·5	69	89	5·6	5·04	13	+ 0·63
Galle	83·3	+0·5	77·6	+0·9	80	84	5·8	3·78	22	— 5·03
Hambantota	88·0	+1·4	76·7	+0·6	74	86	4·0	0·31	3	— 2·45
Jaffna	86·9	+0·7	79·7	+0·4	76	85	4·8	0·20	1	— 2·33
Kandy	86·9	+2·6	68·7	—0·6	68	90	5·1	1·24	13	— 5·20
Kankesanturai	90·8	—	79·1	—	69	85	5·7	0·73	2	—
Kurunegala	89·7	+2·1	74·4	+0·1	67	86	5·6	2·41	11	— 3·14
Mannar	88·1	+0·4	78·6	—0·2	78	89	5·2	0	0	— 1·24
Nuwara Eliya	69·3	+2·6	52·0	—1·2	80	88	6·0	6·85	16	— 1·39
Puttalam	88·1	+1·3	77·1	—0·8	70	84	5·2	1·12	3	— 0·46
Ratmalana	86·5	—	77·3	—	72	82	6·0	6·91	13	— 0·07
Ratnapura	88·7	+1·6	73·1	—0·5	74	95	5·6	6·29	21	— 8·23
Talawakele	75·2	+3·1	57·2	—1·1	82	97	5·4	7·11	18	— 2·64
Trincomalee	93·5	+1·5	77·6	+0·5	62	76	5·1	0·86	3	— 2·57

WEATHER SUMMARY, SEPTEMBER, 1952

In September again the rainfall was below normal over a large part of the Island. The greater deficits (of order of 10 to 15 inches) occurred in the south-western hill-country and adjacent mid-country, the highest being 17·73 inches at Gona Penigala Estate, 16·43 inches at Norton Bridge, 16·06 inches at Theydon Bois Group and 14·53 inches at Weweltalawa Estate. Deficits in the north and the east were generally small. Slight excesses were found in the immediate lee of the hills, along the south-west coast and in the North-Central Province, the only appreciable excesses being 5·93 inches at Wellawa and 4·47 inches at Sudupanawela.

Greatest monthly totals which were of the order of 10 to 15 inches only occurred inland in the south-west quarter and included 15·38 inches at Ingoya Estate, 14·31 inches at Nivitigala, 13·94 inches at Mont Eden Estate and 12·94 inches at Kalutara (P. W. D.). Elsewhere in the south-west rainfall ranged mainly from 5 to 10 inches, while in the north and the east the monthly aggregates were much smaller, a few stations in the neighbourhood of Mannar and Batticaloa recording no rain at all.

The weather during the month was mainly of the south-west monsoon type. But, as the winds were dry, rainfall was scanty and conditions were warm and bright. With the weakening of the monsoon about the 25th, afternoon and evening thunderstorms set in, and they were responsible for most of the precipitation during the month.

There were only 2 daily falls over 5 inches during September, 5·95 inches at Kekirawa on the 30th and 5·20 inches at Horaborawewa on the 24th.

Day temperatures were well above normal, while night temperatures were below normal up-country and about normal elsewhere. The highest temperature recorded during the month was 99·3° at Anuradhapura on the 26th, while the lowest temperature for a low-country station was 70·0° at Ratmalana on the 30th and for the whole Island 45·6° at Nuwara Eliya on the 18th. Humidity ranged from 60 to 80 per cent. by day and from 80 to 95 per cent. by night. Cloud amounts and wind strength were about average, the prevailing direction of wind being south-westerly.

D. T. E. DASSANAYAKE,
Director.

Corrections in Weather Summary for August, 1952

RAINFALL

1. The highest monthly total for August is 42·07 inches at Weweltalawa Estate.
2. Among the greatest deficits should be included, 5·39 inches at Pimbura.
3. The highest excess is 25·99 inches at Weweltalawa Estate.
4. In the last paragraph the sentence regarding day humidity should read " Day humidity ranged from 75 to 85 per cent. in the wet zone and from 60 to 75 per cent. in the dry zone ".
5. Mean maximum temperature at Hambantota should be 88·4° and offset + 1·5°.
6. Cloud amounts at Badulla and Hambantota should be 6·2 and 4·0 respectively.

D. J. JAYASINGHE.
for *Director.*

METEOROLOGICAL REPORT, OCTOBER, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	88·0	—1·0	73·5	0	73	93	5·2	7·09	15	— 2·63
Badulla	83·5	+0·7	65·3	—0·2	64	92	6·2	1·93	6	— 6·96
Batticaloa	88·9	+1·9	76·0	+0·7	70	86	5·7	3·29	6	— 3·90
Colombo	84·5	—0·5	75·7	+0·9	79	88	7·3	11·01	15	— 2·70
Diyatalawa	77·7	+1·5	60·4	—0·1	69	89	7·0	5·00	10	— 4·18
Galle	81·9	—1·1	76·1	+0·7	82	88	6·4	10·93	22	— 1·12
Hambantota	86·5	+0·3	76·0	+0·7	77	86	5·6	3·12	15	— 1·64
Jaffna	85·6	—0·2	77·9	+0·3	77	86	6·0	5·51	7	— 3·69
Kandy	82·8	—1·5	68·5	0	76	92	6·6	11·01	16	+ 0·47
Kankesanturai	87·3	—	77·5	—	75	89	6·8	3·81	7	—
Kurunegala	85·5	—1·9	73·5	+0·3	76	90	4·8	13·98	16	— 0·88
Mannar	86·1	—0·8	77·8	+0·5	82	91	6·4	4·55	8	— 2·03
Nuwara Eliya	66·7	—0·9	52·9	+1·0	81	88	6·8	13·14	16	+ 3·38
Puttalam	85·7	—0·5	76·5	+0·9	76	86	6·3	8·09	10	+ 0·66
Ratmalana	84·0	—	75·6	—	77	88	6·8	11·47	18	— 1·73
Ratnapura	86·0	—1·1	73·2	+0·4	77	95	6·6	19·56	17	+ 1·55
Talawakele	76·4	—0·9	58·0	+0·3	81	94	6·0	14·29	17	+ 4·23
Trincomalee	89·7	+1·8	76·5	+0·9	66	79	6·5	7·17	7	— 2·38

WEATHER SUMMARY, OCTOBER, 1952

The weather over the Island in October was influenced by a depression in the Bay of Bengal, resulting in heavy rain with strong winds during the first week. Heaviest rain was experienced on the 3rd, when a number of stations on the south-western slopes of the hills registered falls exceeding 5 inches. Rainfall continued, confined to the south-western parts, till about the 10th. On account of these heavy rains, a minor flood occurred on the Kelani Ganga, and lasted for several days from the 6th. Rainfall decreased gradually thereafter, and the dry weather that set in about the 15th continued for about two weeks. Fairly widespread rain was experienced again on the last two days of the month, with several daily falls over 5 inches in the North-Western Province on the 31st.

Rainfall was heaviest on the south-western slopes of the hills and the adjacent mid-country, where several stations received monthly totals over 30 inches, the highest being 48·93 inches at Gona Penigala Estate, 43·56 inches at Weweltalawa Estate, 41·99 inches at Padupola and 40·75 inches at Kenilworth Estate. From there the rainfall decreased gradually towards the south-west, the monthly totals along the south-west coast ranging from 10 to 15 inches. In the north and the east of the Island the rainfall was mainly below 5 inches. Least rain was experienced in a few limited areas along the east and south-east coasts, where the monthly totals were below 2 inches.

Rainfall was above normal on the south-western slopes of the hills and the adjacent mid-country and in the southern parts of the North-Western Province, several stations recording excesses above 10 inches including 27·31 inches at Gona Penigala Estate, 18·05 inches at Weweltalawa Estate and 17·43 inches at Kalatuwawa. Elsewhere over the Island the rainfall was generally below normal, the larger deficits (of the order of 5 to 10 inches) occurring on the eastern and north-eastern slopes of the hills and along the north-east coast. The greatest deficits were 11·24 inches at Koslanda, 10·14 inches at Lemastota Estate and 9·73 inches at Udahena Estate.

There were 76 daily falls over 5 inches during the month, a majority of them occurring on the 3rd. The highest were 9·62 inches at Maliboda Estate and 9·60 inches at Kellie Estate on the 3rd.

Day temperatures were above normal on the east side and below normal elsewhere, while night temperatures were above normal generally. The highest temperature recorded during the month was 92·8° at Batticaloa on the 24th, while the lowest temperature for a low-country station was 66·5° at Anuradhapura on the 29th and for the whole Island 41·4° at Nuwara Eliya on the 21st. Day humidity ranged from 65 to 85 per cent. and night humidity from 80 to 95 per cent. Cloud amounts and wind strength were above average, the prevailing direction of wind being south-westerly.

D. T. E. DASSANAYAKE,
Director.

METEOROLOGICAL REPORT, NOVEMBER, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	86·0	+0·2	70·6	—1·1	77	95	5·6	4·90	16	— 5·77
Badulla	78·6	—0·7	65·0	—0·5	74	94	5·8	7·09	18	— 3·16
Batticaloa	84·1	—0·1	73·8	—0·5	79	93	5·6	10·79	17	— 3·07
Colombo	85·1	—0·2	73·2	—0·2	76	93	5·5	12·48	14	— 0·61
Diyatalawa	75·0	+0·9	59·4	—0·5	77	91	6·2	8·30	21	— 2·12
Galle	83·2	—0·4	74·2	—0·1	79	90	6·0	14·34	16	+ 2·33
Hambantota	86·0	+0·7	74·2	+0·2	76	88	5·6	5·04	16	— 2·53
Jaffna	84·3	+0·3	75·0	+0·2	75	86	5·8	13·83	15	— 3·44
Kandy	83·0	—1·0	67·0	—1·1	74	95	5·6	6·69	14	— 4·33
Kankesanturai	83·7	—	75·5	—	76	84	6·4	13·37	13	—
Kurunegala	86·2	—0·8	71·0	—1·0	72	93	5·5	12·26	16	— 0·13
Mannar	85·1	+0·5	76·1	+0·5	76	86	5·8	2·88	11	— 7·31
Nuwara Eliya	68·0	+0·3	51·1	—0·1	78	84	6·1	4·94	16	— 4·25
Puttalam	85·4	—0·2	72·8	—0·5	75	93	5·4	3·43	10	— 6·70
Ratmalana	85·5	—	73·1	—	77	90	5·6	9·80	14	— 2·32
Ratnapura	88·1	+0·5	71·4	—1·0	76	95	6·4	12·31	19	— 2·48
Talawakele	73·2	—0·4	56·2	—1·1	78	88	5·5	6·34	17	— 2·16
Trincomalee	83·8	+0·2	74·8	0	74	84	6·2	8·18	15	— 5·76

WEATHER SUMMARY, NOVEMBER, 1952

The rainfall in November was, on the whole, a little below normal, the greater deficits being mainly of the order of 5 to 10 inches. The greatest deficits were 10·95 inches at Mont Eden Estate and 10·15 inches each at Talaimannar and Weweltalawa Estate. Slight excesses, of the order of 2 to 5 inches, occurred scattered in places, the highest being 4·91 inches at Minipe, and 4·75 inches at Jaffna College.

The distribution of rainfall over the Island generally ranged from 10 to 20 inches. The highest totals, which occurred on the north-eastern hill-slopes and among the Deniyaya Hills, included 28·08 inches at Opata, 24·08 inches at Hendon Estate, 23·59 inches at St. Martin's (Lower) Estate, and 23·15 inches at Kuchchaveli. Least rain was experienced in the North-Western Province and in the south-eastern coastal regions, where the totals recorded were generally less than 5 inches.

The weather during the month was mainly of the inter-monsoon type, with afternoon or evening thundershowers occasionally. They were experienced more extensively during the first 4 days, on the 7th and again for about 5 days from the 16th. About the 29th, a sharp fall in the barometric pressure in the North indicated the approach of a severe cyclonic storm, which caused considerable damage in the Jaffna Peninsula and neighbourhood, on the 30th, from winds of huricane strength. At a number of places raging seas lashed the northern coast line with disastrous results.

There were 45 daily falls over 5 inches in November, the highest being 10·28 inches at Crystal Hill Estate on the 16th and 8·70 inches at Jaffna College on the 19th.

Temperatures have been, on the whole, a little below normal, both by day and by night. The highest temperature recorded during the day was 92·8 °F at Ratnapura on the 17th, while the lowest temperature for a low-country station was 63·2°F at Anuradhapura on the 14th, and the lowest for the whole Island 42·2°F at Nuwara Eliya on the 11th. The mean humidity ranged from 75 to 80 per cent. by day and from 85 to 95 per cent. by night. Cloud amounts and wind strength were about average, the direction of wind being variable.

D. T. E. DASSANAYAKE,
Director.

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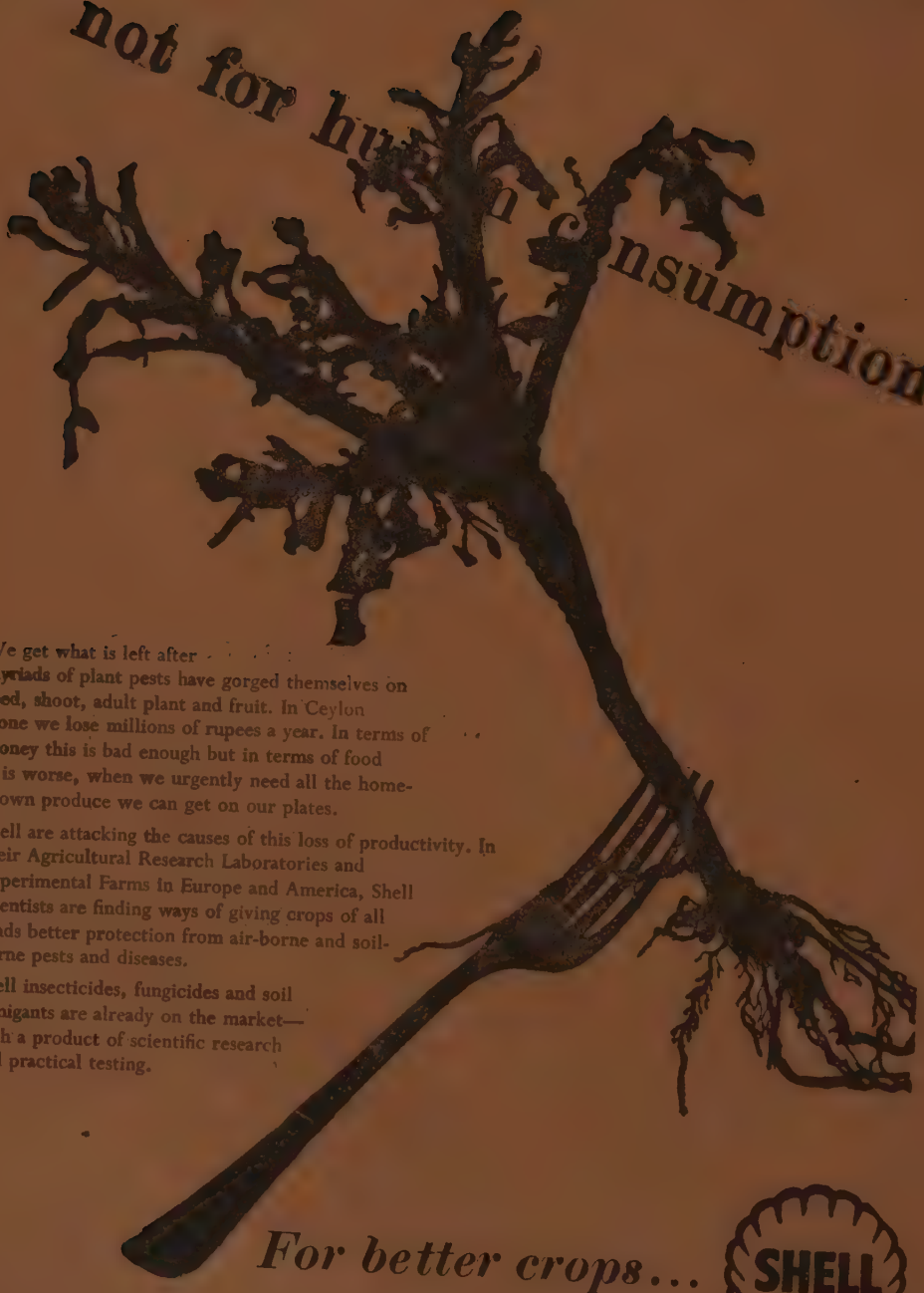

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The

Tropical Agriculturist

January to March, 1953

EDITORIAL

Land Tenancy in Paddy Cultivation and the Paddy Lands Act

IT is generally agreed that one of the main reasons for the relatively low average yield of paddy in Ceylon, as compared with that of some rice-growing countries, is the existence in many districts even today of an ancient tenure system which provides little incentive to the tenant farmer to adopt improved methods of cultivation. In recent years demonstrations conducted by the Department's extension officers on the cultivator's own fields of such practices as transplanting, harrowing the growing crop, artificial manuring, and pest and disease control, have convinced him that these are of considerable benefit from the point of view of crop yield. But he is not easily persuaded to adopt them for while he has more often than not to bear the extra cost of the operations, the additional profits have to be shared with the landlord. There is also in many areas the problem of insecurity of tenure. The questions of the ownership of and tenancy conditions relating to paddy lands formed part of a comprehensive inquiry on paddy cultivation in the Island by a number of District Sub-Committees appointed by the Board of Agriculture in 1928. The reports of these Committees were published in 1930 * and are of considerable interest and value to all those connected in any way with this national industry.

The vital part that paddy production plays in the economy of the Island was forcibly brought home to Government and the people during and since the last War. Every inducement that was likely to promote an increased production of the crop, e.g., the development of irrigation schemes and the settlement of people thereon, a fair guaranteed price for paddy, subsidized manure, grants for the adoption of improved practices, premia on pure line seed paddy, &c., was offered the cultivator ; but despite an increased crop

*(1) Reports of the Sub-Committees Appointed to Inquire into Paddy Cultivation in Ceylon.
(2) Inquiry into the Conditions of Paddy Cultivation in Ceylon.

output there was a still a wide gap between production and the Island's requirement of rice for feeding a rapidly-increasing population even on a very moderate ration.

During these years of effort towards achieving a greater self-sufficiency in our staple diet, viz., rice, it became apparent to Government that social and economic factors, e.g., the tenancy system, fragmentation of holdings, and multiple ownership, were in some districts, at any rate, limiting increased production to a greater extent than inadequate technical know-how on the part of the cultivator. Legislation was accordingly introduced early this year to ensure to the tenant-farmer security of tenure and to restrict the rent recoverable by the landlord from him. The Paddy Lands Act by which this bill is known may well be claimed as the most important measure of social legislation affecting paddy cultivation that has been passed since the epoch-making Crown Land Development and Alienation Ordinance of 1935. It provides for the letting of a " controlled paddy land ", which is one situated in an area in which the Act operates, for a minimum period of five years, and for the framing of regulations prescribing, for different areas, the amounts in money or kind of the " authorized rent " per annum. It also prohibits " the demand or receipt in addition to the rent of any commission, premium, gratuity or other like payment or pecuniary consideration as a condition of the grant, renewal or continuance of the tenancy ". The Act is reproduced in full in this number of *The Tropical Agriculturist* because of its fundamental importance.

In order to appreciate the far-reaching implications of this new Act in relation to rural economic conditions in the Island, it will be useful to survey briefly the present position in regard to the ownership of paddy lands in Ceylon and the tenancy conditions pertaining thereto.

In practically all parts of the Island the share or *ande* system of tenure prevails, the tenant's *net* share of rent for the land after deducting expenditure incurred by the landlord, e.g., on seed paddy and manure, or by himself, being generally half the crop. In a few districts, however, the tenant's share is only a third of the crop, but this is because the landlord bears the expenses e.g., the cost of seed paddy, buffaloes, &c.

Only in the Jaffna District and in some parts of the Batticaloa District and lower Uva is a fixed rental system in operation. The amount of rent charged depends on the fertility of the land but is generally of the order of five bushels per acre per crop. There is yet another system known as the *podi* or hire system which operates mainly in the Batticaloa District, where the landowner engages labour to cultivate his fields and pays them with a part of the crop or the produce of a definite area. In general it should be stated that there is reasonable security of tenure to cultivators in most districts where the agreement is directly between landlord and tenant ; but in a few areas, e.g., in the Hambantota District, where the business is controlled by a landlord's agent known as the *gambaraya*, there is rather less security of tenure. In many districts a prospective tenant has to pay a sum of money to secure the right to cultivate a field. This is termed *madaran* and varies in different

districts from a couple of rupees to Rs. 10 per acre. Where seed paddy is loaned by the landlord, it is returned by the tenant with 50 per cent. interest at harvest.

In regard to the ownership of paddy lands, it is reckoned that up to 75 per cent. of the area in any district is owned by landlords who, except in a few areas like the Kurunegala District, lease the fields to tenants for cultivation. The size of the holding leased varies with the district from a fraction of an acre to about 30 acres generally, but in most of the densely-populated areas the extent cultivated by a tenant is seldom over an acre. In view of the extreme pressure for paddy land in these districts it would be apparent that unless cultivators are assured of secure and fair tenancy conditions they will not readily adopt modern methods of cultivation which, however productive of increased yields, would involve them in added expenditure. The Paddy Lands Act will ensure for them security of tenure and fair rental terms, but in the first instance the Act will be operated only in certain areas as a trial. With experience gained in its working, it will later be extended to other parts of the country. Regulations under the Act have now been framed and will shortly be submitted to Parliament for its approval. There is little doubt that with goodwill on the part of both landlord and tenant, and through the benevolent neutrality of the District Revenue Officer, the "proper authority" under the Act, its operation in due course throughout the Island would result in nothing but benefit to the two parties alike and to the country at large by way of a greatly enhanced output of our staple food.

Other disadvantageous features of paddy land ownership in Ceylon, viz., the *tattu maru* system whereby a field owned by a number of members of a family is cultivated by each of them in successive seasons, and the fragmentation of holdings resulting from the laws of inheritance in vogue in the country, need little comment here because they relate only to owner-cultivators and do not therefore come within the scope of the present Paddy Lands Act. It is clear, however, that both these detrimental social practices in our rural economy have sooner or later to be remedied if the best use is to be made of our paddy lands.

ORIGINAL ARTICLES

Growth and Developmental Changes caused by Pre-sowing Treatment of Seed Paddy *

BY

D. V. ARIYANAYAGAM

INTRODUCTION

IN a paper entitled " Pre-sowing treatment of paddy for drought resistance " read before the Agriculture and Forestry Section of the Ceylon Association of Science last year, I outlined the results of yield trials which were designed to investigate the effect of pre-sowing treatment on the yield of paddy under conditions of normal and reduced irrigation. It was stated that increases in yield varying from 12 to 46 per cent. over control were obtained. Further investigations were subsequently undertaken in *Maha* 1951/52 to obtain more precise information regarding the effect of the treatment on the growth and development of the plant. The main object was to determine which of the yield components of the plant was responsible for the increase in yield.

METHODS

The pre-sowing hardening treatment consists of 3 operations which described in sequence are :—

(1) Soaking the seed in water for a certain period,
(2) Keeping the seed in air in a wet condition for a certain period,
(3) Air-drying the seed till completely dry.

The duration of the first two operations and the number of times the seed is so treated varies. In the experiment described here 4 treatments were tested on *Vellai Ilankalayan* paddy. For the sake of brevity each treatment is represented by 3 numbers. The first number gives the period in hours of soaking the seed in water ; the second number gives the period in hours of keeping the soaked seed in air in a wet condition ; and the third number gives the number of times the seed is treated. The 4 treatments were :—

0/0/0 (untreated control)
6/6/2
12/6/1
and 12/6/2

* A paper read at the Ceylon Association of Science, Agriculture and Forestry Section in December, 1952.

There were 8 replicates of 4 plots each. Sowing was done by dibbling 2 to 3 seeds per point and later thinning out was done to one seedling per hill. Samples of a sufficient number of plants from each replicate were taken at intervals (which varied from one week to a month) and the following observations were made on each sample :—

height of plant ; length of the main stem ; number of tillers ; number of fully expanded green leaves ; fresh weights and dry weights of leaves, shoots and earheads ; number and length of earheads ; number of grains ; 100–grain weight ; and dates of spike initiation, unfolding of flag leaf, emergence of earhead, and flowering.

The roots were rejected in all the samples.

At maturity, 210 plants left over in each plot after the samples were taken, were harvested and the yield determined.

RESULTS

It is convenient to deal with the results obtained under 4 headings, viz., yield data, developmental data, growth data and derived data.

Yield Data

The total yields expressed as percentages of the control were :—

0/0/0—100·0
6/6/2—107·9
12/6/1—103·5
12/6/2—136·2

Variance analysis (Table I in Appendix) showed that treatment 12/6/2 outyielded all other treatments significantly at the 1 per cent. point. It gave an increase in yield of 36.2 per cent. over control.

Developmental Data

It was clear from the data that the treatments induced earliness in the plants. The treated seed germinated about one day earlier than the untreated seed. Spike initiation occurred in all treatments between the 57th and 64th days. Since the spikes were not dissected out daily the exact dates could not be ascertained, but it was noted after initiation that the spikes in the treated plants were more advanced. The number of days taken for the unfolding of the flag leaves, first emergence of earheads and first flowering are shown in the following Table :—

Treatment	*No. of days taken for*		
	unfolding of flag leaf	*first emergence*	*first flowering*
0/0/0 (control)	77·0	83·9	85·1
6/6/2	74·8	80·1	81·3
12/6/1	75·8	81·3	82·6
12/6/2	75·9	80·8	81·8

It will be noticed that the treatments accelerated the unfolding of the flag leaves by 1·1 to 2·2 days, the first emergence of earheads by 2·6 to 3·8 days and first flowering by 2·5 to 3·8 days.

The most obvious and important developmental change caused by pre-treatment was on tillering. Diagram I shows the number of tillers produced per plant on each sampling date for the different treatments. It will be seen that the treatments caused earlier tillering and a larger number of tillers than control. Treatment 12/6/2 produced the largest number of tillers ; treatments 12/6/1 and 6/6/2 occupied intermediate places between 12/6/2 and control. Since the leaves and earheads are produced on the tillers, the number of green leaves (Table II in Appendix) at each sample and the number of earheads produced were highly correlated with the tiller number. The number of earheads and number of grains produced per plant are given in the following Table :—

Treatment	*No. of earheads per plant*	*No. of grains per plant*
0/0/0 (control)	2·8	406·9
6/6/2	3·4	452·5
12/6/1	3·0	438·3
12/6/2	4·3	505·2

The above data indicates clearly that the treatment accelerates the development of the plant and induces greater tillering.

Growth Data

The treated plants were taller than control in the earlier samples but there was very little difference in the final heights attained. There were no changes in the earhead length and the 100-grain weight as a result of the treatments. But the fresh weight and dry weight data showed marked differences. The fresh weights of leaves, shoots and earheads of the treated plants (Table III in Appendix) were more than those of control for all the samples. The dry weight data (Table IV in Appendix) also gave similar results. Diagram II shows the total dry weight of the aerial portion of the plant for the different treatments on each sampling date. The curves are all of a sigmoid type—those for the treated plants occupying a higher position than that for control, thus showing that the maximum dry-weight attained as well as the rate of dry-weight production was more in the treated plants than in the untreated.

Derived Data

The *absolute moisture content* of the treated plants was more than that of the control for all the samples but it was found that the percentage moisture content (Table V in Appendix) calculated on fresh weight was more for the treated plants only till the 5th sample (i.e., 36 days from sowing). After

this the percentage moisture content of the untreated plants was higher than that of the treated plants. The higher moisture content per unit weight of plant material in the early stages of growth caused by the pre-treatment of seed, probably accounts—at least partly—for the capacity of the plant to endure drought.

The *relative growth rate* or *Blackman's "Efficiency Index"* was calculated using the formula :—

$$R = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

where R = Relative growth rate

W = Dry weight of the plant on the different sampling dates

$t_2 - t_1$ = Interval between samples.

The relative growth rates between samples (Table VI in Appendix) for the different treatments are shown in Diagram III. It will be seen that the relative growth rates for the treated plants were greater than those of the untreated up to about 50 days. Later when the relative growth rates declined there was very little difference. Since the relative growth rate or the "efficiency index" represents the efficiency of the plant as a producer of new material, it is obvious that the treated plants were more efficient in this respect.

The higher efficiency of the treated plants can be illustrated in another way. The above formula may be also written in the following form :—

$$\log_e W_1 = \log_e W_o + Rt_1$$

where W_o = the initial dry weight

W_1 = the dry weight attained after a period t_1

and R = relative growth rate or "efficiency index".

When the values of $\log_e W$ are plotted against t, a straight line graph should be obtained if R is constant and the gradient should give the value of R.

The graphs obtained for control and treatment 12/6/2 are shown in Diagram IV. It will be seen that the graph for the treated plants is steeper than that for control, showing that the value of R (i.e., the "efficiency index") is higher in the treated plants. The graphs for the other treatments occupied intermediate positions between those shown here. It is also of interest to note that each graph consists of 3 straight line parts with the breaks occurring on the 64th day and 92nd day. These breaks coincide with the approximate times of floral initiation and flowering. At each of these important events in the plant's life the "efficiency index" is reduced. The first part of the graph corresponds to the vegetative phase, and is characterised by a higher

" efficiency index " of the treated plants. In the second and third parts of the graph, which correspond to the flowering and seed development phases, the " efficiency indices " of the treated and control plants were almost the same. It is clear, therefore, that pre-treatment of seed increases the efficiency of the plant in the vegetative phase only.

The *net assimilation rate* was calculated from the formula :—

$$E = \frac{W_2 - W_1}{L_2 - L_1} \times \frac{\log_e L_2 - \log_e L_1}{t_2 - t_1}$$

where E = Net assimilation rate.

W = Dry weight of the plant on the different sampling dates.

L = Dry weight of the leaves on the different sampling dates.

$t_2 - t_1$ = Interval between samples.

The net assimilation rate has been defined as the rate of increase in the dry weight of a plant per unit of active " growing material ". The leaf dry-weight is a suitable index of active " growing material " during the vegetative phase of the plant. The above formula for calculating net assimilation rate holds good only if the relationship between the leaf dry weight and total dry weight is linear. In the present case an approximate linear relationship was found up to the time of flowering. Diagram V shows the variation in the net assimilation rate with time for the different treatments up to flowering. The net assimilation rates (Table VI in Appendix) of the treated plants were consistently greater than those of the control ; i.e., the rate of increase in the dry weight of the plant per unit of leaf dry weight was intensified by the treatment. In other words, the food material produced by a leaf from a treated plant was more than that produced by a leaf of identical size and weight from an untreated plant.

DISCUSSION

So far, it has been shown that pre-sowing treatment of seed causes an increased rate of growth and development and an intensification of the Relative Growth Rate and Net Assimilation Rate culminating in higher yields of the subsequent plants. In order to explain this yield increase it is necessary to postulate a working hypothesis, into which should fit in all the apparently disconnected data which have been collected.

The primary effect of the treatment is to increase the efficiency of the plant. The leaves of the treated plants are enabled to photosynthesise more food material per unit weight of leaf. There are many factors which affect the rate of photosynthesis in plants. The external factors remain the same for the treated and untreated plants. At least three internal factors which may influence the rate of photosynthesis have been suggested, viz., chlorophyll, water content of the assimilating cells and an unknown protoplasmic factor.

The chlorophyll content may be ruled out as this is never a limiting factor in normal leaves. The water content, even in the leaves, has been found to be higher in the treated plants up to 36 days only. But the net assimilation rate has been higher right up to flowering. Hence, it is not likely that the change in water content is responsible for the increase in efficiency of the treated plants. The effect of the treatment should be therefore on the unknown protoplasmic factor. This factor is influenced in some way, which may be enzymic, so as to increase the net assimilation rate.

The increase in the net assimilation rate is also reflected in the " efficiency index ". The intensification of the efficiency is manifested in the paddy plant by the production of a larger number of tillers and consequently of more earheads.

The components which contribute to the yield from a paddy plant are the number of earheads, the number of grains per earhead and the weight of a grain. The number of grains per earhead and the 100–grain weight are not increased by the treatment. The increase in yield caused by pre-sowing treatment is therefore due entirely to the increase in the number of earheads.

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APPENDIX

Table I—Analysis of Variance of Yield Data

Due to	*DF*	*SS*	*MS*	*F*
Blocks	7	7·01	1·001	6·42*
Treatments	3	10·34	3·447	22·10*
Error	21	3·27	0·156	
Total	31	20·62		

* Significant at the 1 per cent. level.

Table II—Number of Tillers and Number of Green Leaves per Plant

Age in Days	*0/0/0 Control*		*6/6/2*		*12/6/1*		*12/6/2*	
	Tillers	*Leaves*	*Tillers*	*Leaves*	*Tillers*	*Leaves*	*Tillers*	*Leaves*
15	1·00	1·99	1·00	2·17	1·00	2·16	1·00	1·92
22	1·17	3·62	1·18	3·56	1·33	3·79	1·29	3·77
29	1·47	3·94	1·69	4·24	1·82	4·63	1·99	5·18
36	2·07	5·65	2·72	6·72	2·79	6·98	2·64	6·57
50	2·81	7·25	3·25	8·06	3·57	9·51	4·12	10·50
64	2·83	7·50	3·41	9·00	3·58	9·37	4·33	11·17
92	4·00	13·00	3·79	12·28	3·91	13·54	4·37	13·54
120	3·88	5·91	4·33	4·92	3·92	4·28	4·75	6·58

Table III—Fresh Weight Data of Green Leaves, Shoots, and Earheads, in Grams per Plant

Age in days	*0/0/0 Control*			*6/6/2*			*12/6/1*			*12/6/2*		
	Leaves	*Shoots*	*Ear-heads*	*Leaves*	*Shoots*	*Ear-heads*	*Leaves*	*Shoots*	*Ear-heads*	*Leaves*	*Shoots*	*Ear-heads*
15	·036	·071	—	·048	·055	—	·043	·066	—	·034	·076	—
22	·099	·157	—	·114	·176	—	·119	·202	—	·118	201	—
29	·195	·430	—	·215	·462	—	·229	·471	—	·302	·546	—
36	·372	·906	—	·494	1·05	—	·510	1·08	—	·452	1·01	—
50	1·09	4·33	—	1·44	5·62	—	1·93	7·35	—	2·31	8·94	—
64	2·69	14·47	—	2·82	16·20	—	3·08	16·52	—	3·80	19·24	—
92	5·65	42·43	4·02	5·34	41·29	4·03	5·78	54·50	4·00	6·10	60·12	4.38
120	2·36	34·03	12·69	2·53	39·23	13·56	2·42	38·67	13·39	2·60	49·10	16·74

Table IV—Dry Weight Data of Green Leaves, Shoots, Earheads, and Total Dry Weight (excluding Roots), in Grams per Plant

Age in Days	*0/0/0 Control*				*6/6/2*				*12/6/1*				*12/6/2*			
	Leaves	*Shoots*	*Ear-heads*	*Total*	*Leaves*	*Shoots*	*Ear-heads*	*Total*	*Leaves*	*Shoots*	*Ear-heads*	*Total*	*Leaves*	*Shoots*	*Ear-heads*	*Total*
15	·0093	·0164	—	·026	·0114	·0153	—	·027	·0111	·0157	—	·027	·0086	·0173	—	·026
22	·024	·033	—	·057	·026	·033	—	·059	·027	·035	—	·062	·025	·033	—	·058
29	·049	·070	—	·119	·047	·068	—	·115	·052	·070	—	·122	·051	·068	—	·119
36	·085	·090	—	·175	·093	·098	—	·191	·095	·101	—	·195	·089	·097	—	·186
50	·317	·557	—	·874	·386	·746	—	1·132	·582	1·190	—	1·772	·617	1·434	—	2·051
64	·764	2·101	—	2·865	·928	2·596	—	3·524	1·067	2·600	—	3·667	1·148	3·570	—	5·718
92	2·07	9·65	1·83	13·55	1·79	10·20	2·04	14·03	2·14	12·00	2·18	16·32	2·39	16·08	2·14	20·61
120	·93	8·19	9·22	18·34	·99	9·86	10·36	21·21	·96	10·87	10·27	22·10	1·07	14·94	10·63	26·64

Table V—Absolute Moisture Content in Grams per Plant and Percentage Moisture Content on Fresh Weight

Age in Days	*0/0/0 Control*		*6/6/2*		*12/6/1*		*12/6/2*	
	abs.	*per cent.*	*abs.*	*per cent.*	*abs.*	*per cent.*	*abs.*	*per cent.*
0 (seed)	·0026	8·37	·0027	8·70	·0028	8·94	·0028	9·03
15	·081	75·70	·076	73·78	·082	75·22	·084	76·36
22	·199	77·73	·232	80·00	·259	80·65	·261	81·84
29	·506	80·96	·562	83·01	·578	82·57	·729	85·96
36	1·103	86·30	1·353	87·62	1·394	87·67	1·272	87·24
50	4·546	83·88	5·928	84·19	7·508	80·91	9·199	81·77
64	14·295	83·33	15·496	81·50	15·933	81·27	17·322	75·28
92	38·55	73·99	36·63	72·30	47·96	74·61	49·99	70·80
120	30·74	62·63	34·11	61·65	32·38	59·41	41·81	61·08

Table VI—Relative Growth Rate in Grams per Week and Net Assimilation Rate in Grams per Gram per Week

Between Days	*0/0/0 Control*		*6/6/2*		*12/6/1*		*12/6/2*	
	RGR	*NAR*	*RGR*	*NAR*	*RGR*	*NAR*	*RGR*	*NAR*
15–22	·785	1·980	·765	1·755	·831	1·973	·802	2·097
22–29	·736	1·757	·685	1·610	·677	1·584	·719	1·682
29–36	·386	·857	·507	1·127	·474	1·037	·447	·982
36–50	·804	1·983	·890	2·286	1·101	2·933	1·200	3·420
50–64	·594	1·959	·568	1·935	·182	1·184	·513	2·145
61–92	·388	2·039	·345	2·002	·373	2·052	·321	2·198
92–120	·076	—	·103	—	·076	—	·064	—

DIAGRAM I – NUMBER OF TILLERS

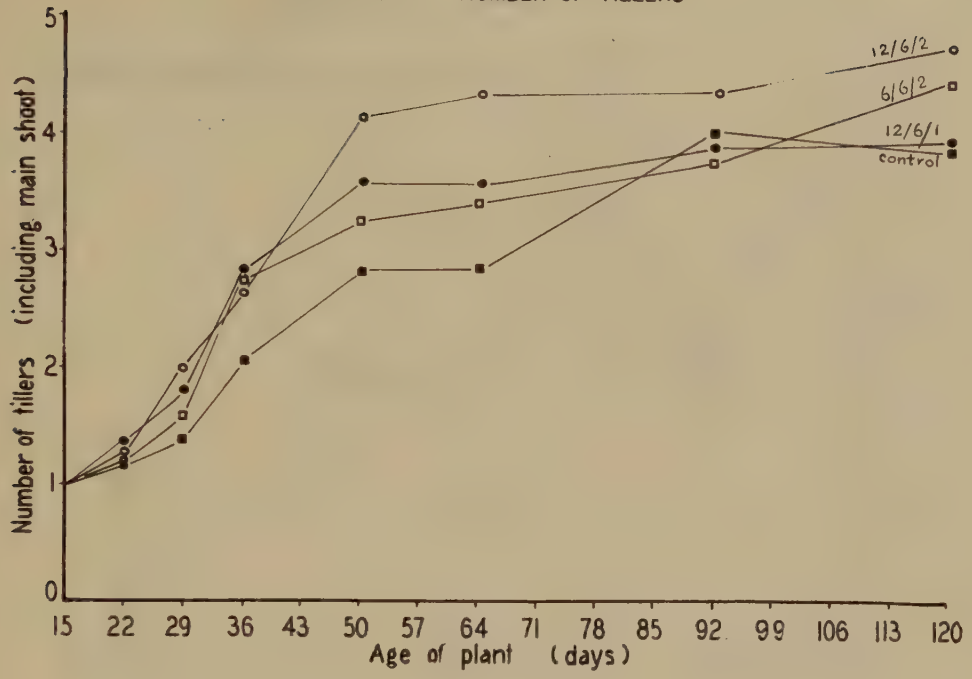
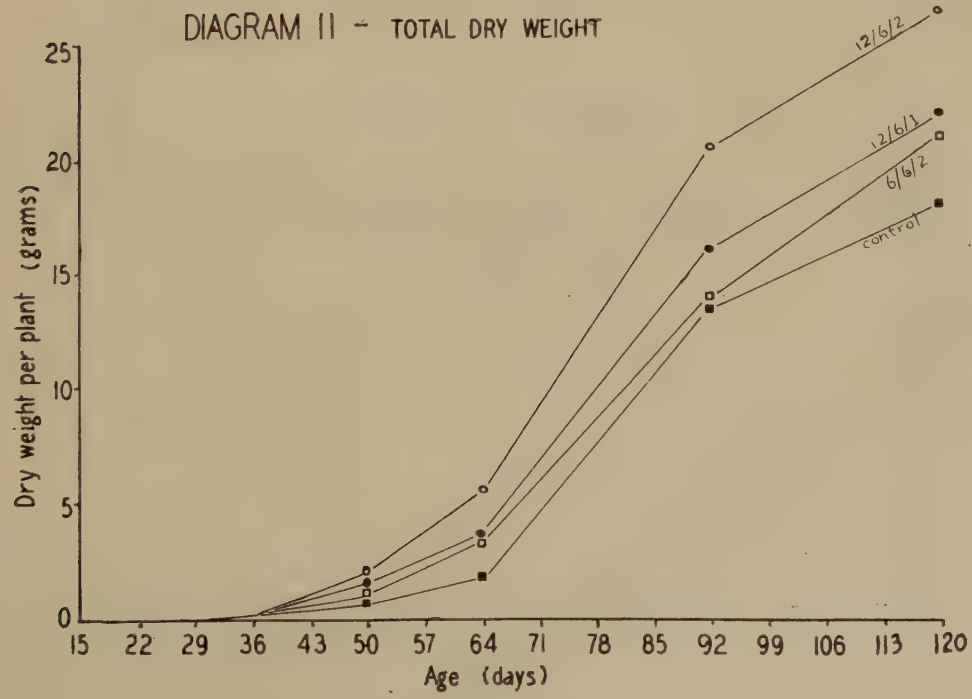


DIAGRAM II – TOTAL DRY WEIGHT



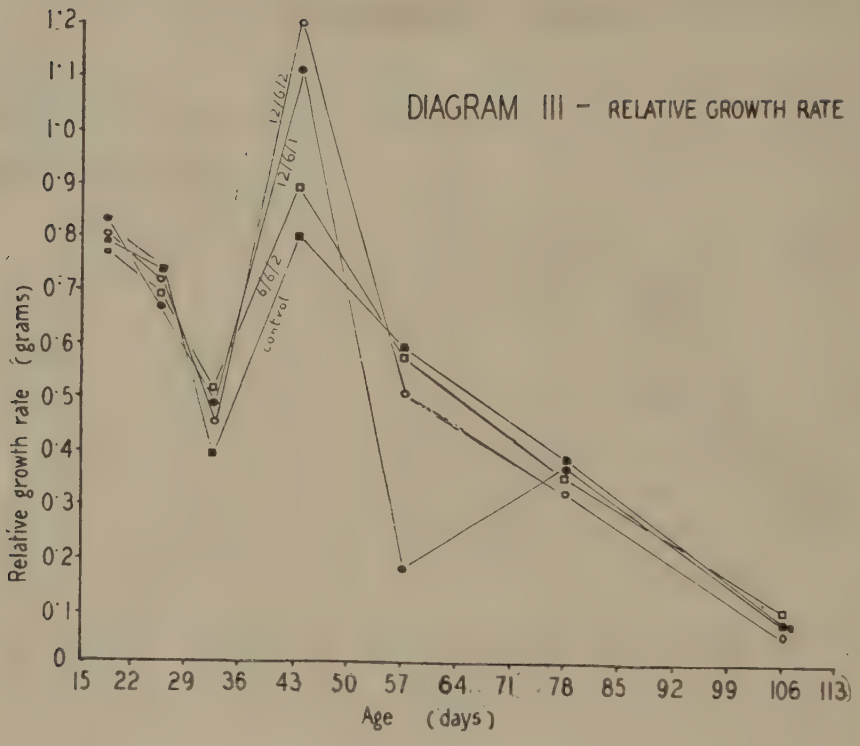


DIAGRAM III - RELATIVE GROWTH RATE
Relative growth rate (grams)
1·2
1·1
1·0
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
0
12/6/2
12/6/1
6/6/2
control
15 22 29 36 43 50 57 64 71 78 85 92 99 106 113
Age (days)

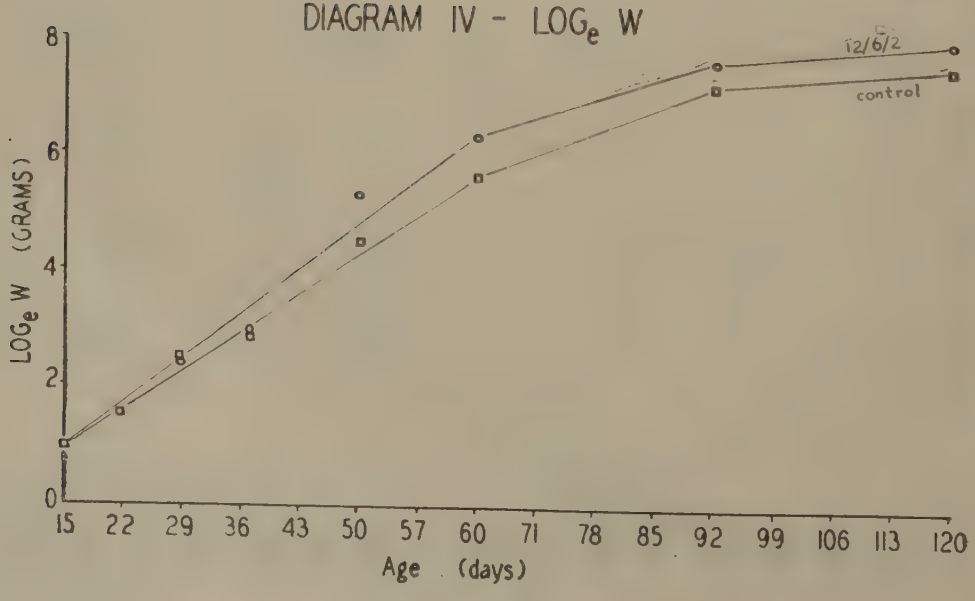


DIAGRAM IV - LOG$_e$ W
LOG$_e$ W (GRAMS)
8
6
4
2
0
12/6/2
control
15 22 29 36 43 50 57 60 71 78 85 92 99 106 113 120
Age (days)

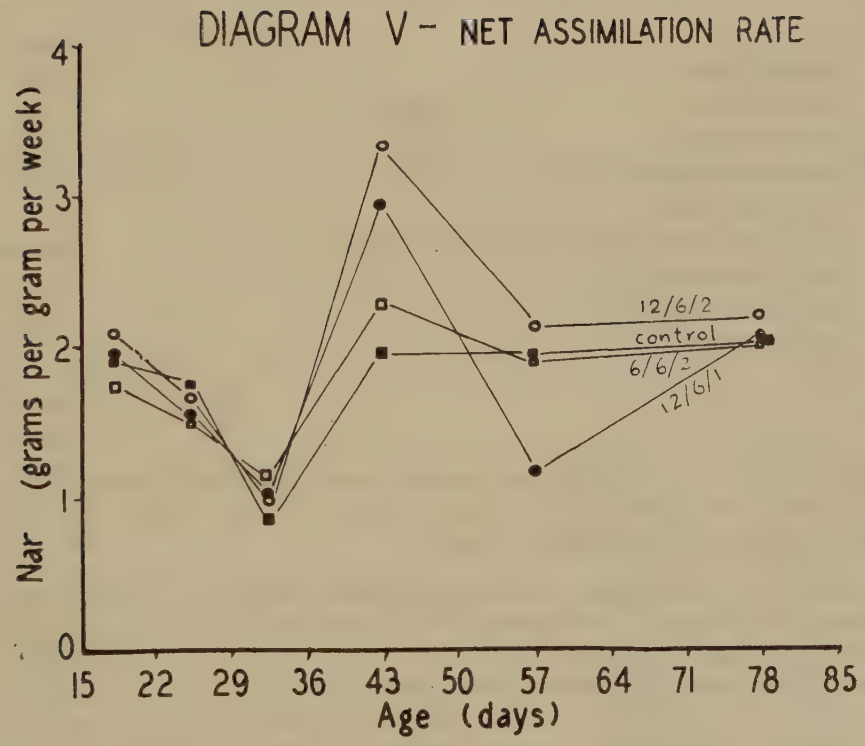


DIAGRAM V - NET ASSIMILATION RATE
Nar (grams per gram per week)
4
3
2
1
0
15
22
29
36
43
50
57
64
71
78
85
Age (days)
12/6/2
control
6/6/2
12/6/1

Saline Paddy Trials in the Eastern Division

BY

D. V. ARIYANAYAGAM

THE extent of saline paddy land in the Batticaloa District is estimated at about 6,500 acres, distributed according to D. R. OO. divisions, as follows :—

	Acres
Panama pattu	441
Akkaraipattu	1,827
Karavaku pattu	991
Sammanturai pattu	702
Wewagam pattu	—
Manmunai South and Eruvil Porativu pattus.. ..	1,000 (approx.)
Manmunai North pattu	650 ,,
Eravur Korale pattu	755
Bintenne pattu	—
Total ..	6,366 (approx.)

These lands are mostly cultivated with local salt-resistant varieties such as *Uvar Karuppan* or *Sarar Karuppan*, *Urar Vellai*, *Kallurundai*, *Perum Karuppan* and *Murugan Samba*.

In order to determine the most suitable variety of paddy for growing under these conditions, a varietal trial was set down on saline land at Vakaneri Farm in the Eravur Korale pattu for *maha* 1950/51 with 18 varieties of local and introduced salt-resistant paddy. The results of this trial are given in Table I. Long, narrow plots (38′ × 8′) were used to reduce the effect of excessive heterogeneity of the soil. The trial was transplanted. The variety *Kagga* had two completely vacant plots and was, therefore, left out of the analysis of variance. The blocks as well as varieties were significant at the 1 per cent. point. *Uvar vellai* (a local variety) and *SR 26* (an introduced Indian variety) out-yielded all other varieties (including *Pokkali*) significantly.

Another varietal trial was set down at the same station for *maha* 1951/52 with 10 selected varieties to confirm the above results. There were eight replicates, four of which were broadcast and four transplanted. The results of this trial are given in Table II. Although transplanting gave an overall yield increase of 41 per cent. over broadcast, the difference was not

significant at the 5 per cent. point. Most varieties yielded more when transplanted. The yield of *Uvar Vellai*, however, was not improved by transplanting. The total yield differences were significant at the 1 per cent. point. *Uvar Vellai* and *SR 26* again gave the highest yields.

Soil samples from the trial area were analysed by the Chemist, who reported that the salt-content varied from 0.20 to 0.44 per cent. (which was considered very saline) and the pH varied from 4.4 to 6.6 (very acidic).

The varieties *Uvar Vellai* and *SR 26* are recommended for cultivation in the saline areas in the Batticaloa District. *Uvar Vellai* is a better yielder and is suitable for growing even under broadcast conditions. Where a shorter-term paddy is required *SR 26*, when transplanted, does very well. The grain is also attractive.

TABLE I

Results of the Salt-resistant Paddy Varietal Trial at Vakaneri Farm for *Maha* 1950-51

Variety	*Yield in lb./acre*	*Per cent. of mean*
Uvar Vellai	2,035·0	175·0
SR 26	2,025·0	174·1
Perum Karuppan	1,430·0	123·0
Gido 251	1,420·0	122·1
Kallurundai	1,390·0	119·5
Hom 504	1,225·0	105·3
Tam Gian	1,200·0	103·2
Giodo 142	1,130·0	97·2
Giong Gian 145	1,120·0	96·3
Tam Lap 136	1,085·0	93·3
Gitrang 131	985·0	84·7
On 134 *b*	950·0	81·7
SR 26B	925·0	79·5
Pokkali	880·0	75·7
Giong 144	850·0	73·1
Bile Kagga	685·0	58·9
Uvar Karuppan	435·0	37·4
Kagga	—	—
Mean	1,163·0	100·0
Standard Error	188·5	16·21

Significant at the 1 per cent. point.

S. D. (P = 0·05) = 46·0 per cent.

(P = 0·01) = 61·5 per cent.

TABLE II

Results of the Salt-resistant Paddy Varietal Trial at Vakaneri Farm for *Maha* 1951-52

Variety	*Age in months*	*Yield in lb./ acre*			*Per cent. of mean of total yield*
		Broadcast	*Transplanted*	*Total* *	
Uvar Vellai ..	4½ ..	1,695·0 ..	1,685·0 ..	1,690·0 ..	151·7
SR 26	3¾ ..	855·0 ..	1,940·0 ..	1,397·0 ..	125·4
Kallurundai ..	4½ ..	1,240·0 ..	1,510·0 ..	1,375·0 ..	123·4
Murugan Samba ..	4 ..	990·0 ..	1,565·0 ..	1,277·5 ..	114·7
Hom 504	4 ..	835·0 ..	1,620·0 ..	1,227·5 ..	110·2
Gido 251	4 ..	845·0 ..	1,225·0 ..	1,035·0 ..	92·9
Perum Karuppan ..	4 ..	805·0 ..	1,035·0 ..	920·0 ..	82·6
Tam Gian	4 ..	710·0 ..	1,000·0 ..	855·0 ..	76·8
Pokkali	3¾ ..	620·0 ..	835·0 ..	727·5 ..	65·3
SR 26B	3¾ ..	655·0 ..	615·0 ..	635·0 ..	57·0
Mean	— ..	925·0 ..	1,303·0 ..	1,114·0 ..	100·0
Standard Error ..	..	— ..	— ..	169·5 ..	15·2

* Significant at the 1 per cent. point.

S. D. (P = 0·05) = 43·1 per cent.

Progress of Selection Work on Cacao

BY

A. Y. RICHARDS

SUMMARY

CACAO grown in Ceylon consists of a complex mixture of Criollo and Forastero types, and is not unlike the Trinitario cacao of Trinidad. It does not breed true to type from seed, and has to be propagated vegetatively in order to maintain improvements in yield and quality.

The selection work now in progress has as its main objective the development of suitable healthy clones of cacao which will yield over one ton of cured cacao per acre, and which have pod value of $7\frac{1}{2}$ or less, the pod value being the number of pods which will produce one pound of cured cacao.

Besides the local selections eleven Trinidad clones consisting of Upper Amazonian and Trinitario selections imported by air from Kew. Amelanado cacao from Malaya, and New Guinea Selections from Keravat are under observation.

Pollen incompatibility is not unknown in Trinidad cacao, but some consistent high yielders are found to be both self-compatible and cross-compatible, while many others are only cross-compatible.

Studies on fermentation of cacao have been made to determine the average loss of weight of wet cacao on curing in both large and small sweat boxes. The temperature during fermentation rose to 44.5° C. killing all the embryos in 36 hours in the large sweat boxes at the factory, and the product was well fermented and of good quality, but in the small boxes the temperature did not exceed 33.3°C., many of the beans were under-fermented, and when sown about 42 per cent. germinated even after 36 hours of fermentation.

The average loss of weight on curing at the factory was 63 per cent. compared to 60 per cent. in Trinidad where the cacao is not washed after fermentation as in Ceylon.

INTRODUCTION

Cacao was first introduced into Ceylon by the Dutch in 1819, but was developed commercially as a plantation crop by the British from 1878 onwards when the first export of 10 cwt. of cured cacao was recorded.

Since then the demand for this commodity has shown considerable increase, and in recent years owing to high prices there has also been a marked increase in the planting of cacao.

Large extents of unproductive rubber have been under-planted with cacao during the last few years largely because of the beneficial effect of its shade in increasing humidity under the tree canopy and thereby promoting early bark renewal on the tapping panel. The heavy leaf fall from the cacao trees also helps to suppress weed growth and build up the humus content of the soil, while the crop itself brings in additional income.

Cacao grown in Ceylon in the early years was predominantly of the Criollo type, but owing to admixture of the more dominant Forestero types introduced later it now consists almost entirely of a complex mixture of Criollo and Forastero which is not unlike the Trinitario cacao of Trinidad. These Criollo-Forastero hybrids produce fairly plump beans which are purple in colour when cut, and become red-brown when cured. The true Criollo beans are quite plump, white in the pod, and produce a cinnamon-coloured product when cured, while the Forastero types including the Amazonian Forastero classed as Amelanado have small flattish beans, dark purple in the pod and chocolate-brown when cured. Both Criollo and Trinitario types produce the so-called " fine " cacao of commerce which constitutes 5 to 10 per cent. of the world supply, while the Forastero types produce the " ordinary " cacao which is in great demand by manufacturers whose requirements amount to 90 to 95 per cent. of this variety.

The demand for fine cacao is at present limited, and the premium, if any, it commands is not high enough to justify the sacrifice of yield for quality in the selection of suitable clones. Consequently the aim is to select only high yielding clones which will come into bearing early and produce a good quality cacao acceptable to the trade. In the absence of proved high yielding clones in Ceylon it was decided on the recommendations of the Cacao Research Committee to undertake selection work at Kundasale and other cacao-growing areas where the main crop is in season from October to January and the small spring crop from May to July.

In Trinidad where selection work has been carried out since 1932 under the Cacao Research Scheme the objectives are to select healthy mother trees which under estate conditions produce at least one ton of cured cacao per acre and which show a pod value of $7\frac{1}{2}$ or less, the pod value being the number of pods required to produce one pound of cured cacao assuming 60 per cent. loss of wet weight on curing. Pound (1933).

In West Africa where the West African Forastero type produces very small flat beans which breed almost true to type greater emphasis is placed on total yield per acre than on the pod value which is calculated on 53 per cent. loss of weight.

The loss of weight on fermentation and curing in Ceylon is slightly higher because of the prevailing practice of washing the beans after fermentation in the sweat boxes, the average loss being 63 per cent., and the yield per acre only about 2 to 3 cwt.

With about 190 trees to the acre at a spacing of 15′ × 15′ each tree should yield on an average 12 lb. of cured cacao per year in order to produce one ton per acre. The number of pods per tree which would produce this quantity would vary from 60 to 72 and 84 for pod values of 5, 6 and 7 respectively. Accordingly only trees which give yields of over 60 pods per year and over 5 oz. of wet cacao per pod are considered for selection in the preliminary survey which is being carried out at Kundasale since last September, and all weak growing, diseased and unproductive trees are rejected.

None of the trees whose yields were recorded for over two years at Kundasale and Peradeniya have pod values less than 8, but a few trees have consistently given high yield of pods which on an acre basis works out to over one ton of cured cacao per acre. Thus tree No. 46 in Field 3 with a pod value of 8.9 and average yield of over 150 pods per year for the last four years has set a good crop again this year. A sample of cured cacao from 50 pods collected from it at one picking was graded and sent to the Colombo brokers, Messrs. Keel and Waldock, who reported on it as follows on 5th June, 1952 :—

" This cacao is of good size and of excellent quality, and we feel if sold on this market would be in very good demand, and would always command a ready sale and in all probability fetch a premium."

Grade I was valued at Rs. 195 per cwt. and Grade II at Rs. 192.95 per cwt.

This tree has been provisionally selected as a mother tree, and several single leaf cuttings taken from it have been successfully rooted in propagators for study of their performance in the field.

Imported Clones

The following 11 clones propagated as rooted stem and leaf cuttings at Kew Gardens from clonal materials received from Trinidad were imported early in October, 1952, by air freight through the courtesy of the Director and planted at Batalagoda where they will remain under quarantine for a period of over 6 months :—

ICS	1	ICS	45
ICS	8	ICS	60
ICS	16	ICS	95
ICS	39	ICS	98
ICS	40	NA	32
		PA	35

They consist of Upper Amazonian and Trinitario selections made by the Cacao Research Scheme at the Imperial College of Tropical Agriculture, Trinidad, British West Indies.

The plants were despatched by air from Kew as bare root plants with the roots covered with Sphagnum moss and wrapped in polythene. When the quarantine period is completed satisfactorily the clones will be multiplied and planted out for trial on the field. The pod value of all these ICS clones is less than 7, ICS 8 being the lowest with 5.5, but it remains to be seen whether their performance under local conditions would be any better than that of the Ceylon clones which are being selected locally.

Amelanado Cacao

Two pods of the West African Amelanado cacao were obtained through the courtesy of the Director of Agriculture, Malaya, on October 31, 1952, and 83 seeds extracted from them were sown in plant supply baskets and clay pots at Heneratgoda, and 80 have germinated. This variety of cacao is said to breed nearly true to type from seed, and is being multiplied rapidly in Malaya.

New Guinea Cacao

Seed of eight selections of cacao was obtained by air from the Lowlands Cacao Experiment Station, Keravat, New Guinea, through the courtesy of the Director of Agriculture, New Guinea, and planted under quarantine at Heneratgoda. A representative number of plants of each selection has germinated satisfactorily. Urquhart and Dwyer (1951) in their report on the Growing of Cacao in Papua and New Guinea state that these selections yield from 15 to 18 lb. of cacao per tree per annum, which is a very high yield compared to the average of about 1 lb. of cured cacao per tree per annum in Ceylon. This variety is mainly self-pollinated and apparently breeds fairly true to type from seed.

Studies on Pollen Compatibility

Cacao is normally cross-pollinated in the field by insects such as the cacao flower thrips, midges and aphids; its floral structure does not permit pollen to fall on the stigma without the assistance of a pollinating agent. But in the Trinitario group a considerable number of trees have been found to be self-incompatible though cross-compatible, while others are both self-compatible and cross-compatible. A self-incompatible tree will set fruit when pollen from a self-compatible tree is used, but two trees which are self-incompatible are generally not cross-compatible.

The opportunity was taken to study the pollination mechanism and degree of pollen compatibility when many of the cacao trees at Kundasale came into flower last July. The flower buds were enclosed in cloth-covered glass tubes held in position by rubber bands and putty (Fig. 1) and were pollinated by hand when they opened the following morning. Out of seven

Fig. 1.—3-year old Cacao from Stem Cuttings. Note glass tubes protecting hand-pollinated flowers.

trees which were tested only the provisionally selected tree No. 46 which is a consistent high yielder, was found to be self-compatible as indicated by the following data :—

Tree No.	*No. of flowers selfed*	*No. of pods set*	*Percentage*	*Remarks*
46	28	16	57	Self-compatible
42	60	0	0	Self-incompatible
13	10	0	0	do.
108	19	0	0	do.
C. 4 (Rooted cutting)	58	0	0	do.
C. 5 (Rooted cutting)	12	0	0	do.
CC. 4 (Criollo type)	12	0	0	do.

The following cross-pollinations were also made :—

Crosses	*No. of flowers cross-pollinated*	*No. of pods set*	*Percentage set*	*Remarks*
No. 42 ♀ × 46 ♂	20	16	80	Cross-compatible
No. 46 ♀ × 42 ♂	10	9	90	do.
No. 108 ♀ × 46 ♂	14	13	93	do.
No. CC 4 ♀ × CC. 5 ♂	12	0	0	Cross-incompatible
No. C. 4 ♀ (Rooted cutting) × 46 ♂	4	3	75	Cross-compatible

Tree No. 46 being both self-compatible and cross-compatible is apparently able to set fruit more freely than the others which are only cross-compatible. It should make an excellent pollenizer since its pollen is effective in bringing about satisfactory setting of fruit on the other trees under study. Further observations on pollen compatibility are being made to confirm this.

Studies in Fermentation

In order to determine the percentage loss of weight on fermentation and curing of cacao under local estate conditions bulk samples of wet cacao were weighed and fermented in the large sweat boxes 9′ 6″ long, 6′ broad and 3′ high at the factory at Kundasale for 36 hours. The fermented beans were then washed in running water to remove the disintegrated pulp and dried

in the open sun for a few hours daily for about 5 days, and later for the whole day on the 6th and 7th day. The relevant data are given in the following table :—

Sample No.	*Wet weight of cacao in lb.*	*Duration of fermentation (hours)*	*Method of curing*	*Dry weight of cacao in lb.*	*Percentage of dry weight*	*Date of recording*
1	3,402	36	Flue	1,235	36·3	29. 5.52
2	2,476	,,	,,	850	34·3	30. 5.52
3	1,038	,,	Sun	415	39·9	2. 6.52
4	364	,,	,,	133	36·5	5. 9.52
5	509	,,	,,	179	35·2	9. 9.52
6	1,749	,,	,,	646	36·9	24. 9.52
7	2,032	,,	Flue	821	40·4	27. 9.52
8	2,272	,,	,,	873	38·4	29. 9.52
9	1,002	,,	,,	376	37·5	2.10.52
10	1,461	,,	Sun	529	36·2	6.10.52
11	1,452	,,	,,	536	36·9	10.10.52
12	3,095	,,	,,	1,111	35·8	13.10.52
13	4,155	,,	,,	1,529	36·8	24.10.52
14	8,644	,,	,,	3,012	34·8	27.10.52
15	5,345	,,	,,	2,065	38·6	31.10.52

	Per cent.
Average for flue-cured cacao	37·4
Average for sun-cured cacao	36·8
General average	37·0

The Superintendent of Ross Estate, Matale, has also reported that the loss of weight on curing was 63 per cent.

Attempts were also made to ferment small samples of cacao in miniature sweat boxes of dimension 2 ft. × 1 ft. × 1 ft. high, but the fermentation process was not sufficiently intense and the rise in temperature was not high enough to kill all the embryos in 36 hours.

As will be seen from the following germination records some of the beans from the small sweat boxes retained viability even after 36 hours, but not a single bean from the large sweat boxes remained viable since the rise in temperature was sufficient to kill the embryos within 24 hours.

Germination Records

Fermentation Period (hours)	*Temperature during fermentation in Centigrade*		*Date of sowing*	*Date of germination*	*Percentage germination small boxes*	*Percentage germination large boxes*
	S. Boxes	*B. Boxes*				
0	25·8	25·8	Aug. 28	Sept. 13	54	54
12	28·5	32·6	,, 29	,, 11	68	60
24	31·6	32·2	,, 29	,, 12	42	24
35	33·3	44·5	,, 30	,, 13	42	0

The beans were sown from the 28th to 30th August, 1952, and germinated from 11th to 13th September, 1952, the fresh beans taking three days longer to germinate than those sown 12 hours after fermentation. Similar results were obtained when the trial was repeated again in October, 1952, using 100 seeds for sowing every six hours from each type of box. The cured product from the small boxes was sent to the brokers in Colombo who reported that it contained beans which were under-fermented and slaty in colour. It is clear from these results that the fermentation is not taking place satisfactorily in the small boxes and that the rise in temperature is not adequate to kill the embryos within 36 hours. Proper development of flavour in the cured product is said to be possible only when the embryo is destroyed in time by the heat generated by fermentation.

Pending the development of a satisfactory technique for curing small samples the wet cacao from individual mother trees under study was put into muslin bags and cured with the bulk cacao in the large sweat boxes at the factory. The cured product has been favourably reported upon by the brokers, and is apparently quite satisfactory.

ACKNOWLEDGMENT

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Notes on Legumes III*

BY

W. R. C. PAUL

OBSERVATIONS on legumes, which include a few new introductions, grown in the trial plots at some Agricultural Stations were continued and are recorded in this paper as progress notes.

Leguminous species occur wild, some of which fall within the category of weeds and as cultivated plants of use as food, livestock feed, restorers of soil fertility and for the extraction of oil and fibre. Many wild plants still have potentialities for feed and green manure purposes. Some of the legumes which were originally introduced as ground covers for plantation crops like rubber have now proved to be useful as forage plants. Reference is made to a few which have been found to be of dual value and which for this reason need to be grown more extensively than at present.

I—GREEN MANURE AND SOIL PROTECTING CROPS

The legumes in this category, especially those that develop as ground covers by forming a close, dense carpet over the soil, provide considerable protection to it against the ill-effects of sun, rain and wind.

(*a*) Ground Covers

There are two types—those that have a creeping or a loosely spreading habit like velvet beans and those that grow semi-erect as in the case of stylo.

In arable farming in the dry zone, the Mauritius velvet bean (*Stizolobium aterrimum* Piper and Tracy) has proved to be the most effective legume in providing a complete cover during the dry season from June to September when most other herbaceous vegetation dies down. It fulfils as previously pointed out (5) the following purposes :—(*a*) Protection of the soil from desiccating winds and high temperatures (*b*) suppression of weed growth (*c*) addition of organic matter to the soil through the decay of a large quantity of leaves and stems. It, therefore, deserves an important place in a crop rotation.

The seed should be planted in the dry zone in October or November with the *maha* rains as later planting either in December or January or again in March or April with the restricted *yala* rains does not result in a

* A paper read at the Eighth Annual Sessions of the Ceylon Association for the Advancement of Science held in December, 1952.

sufficiently heavy cover. The crop dies down before the next *maha* season and the succeeding crop in the rotation can be sown in lines made through the dead stubble of the legume which plays the rôle of both a cleaning and a soil improving crop.

Although Stylo (*Stylosanthes gracilis* H. B. & K.) which was introduced in 1946 from Australia forms a good cover over the soil it is very susceptible in the dry zone to attack by the larvae of the small Buprestid beetle (*Spenoptera perotetti* Guer.) which was first observed in 1950 at the Agricultural Station, Pelwehera, and has since been recorded in all other centres in the dry zone where it has been grown. The main stem is attacked at the base and eventually the whole plant dies down. Stylo does well in the wet zone and especially on lateritic gravels, where it is at present the best crop for improving the physical status of such soils. After a few years growth, it forms a good layer of dead stubble above the surface of the soil on which it grows. It also gives promise of being a suitable ground cover for tea.

The Spanish clover (*Desmodium uncinatum* (Jacq.) D.C.) is a new legume, seed of which was brought by Mr. A. V. Richards, Horticultural Officer, from the Queensland Department of Agriculture on his return to Ceylon in September, 1951. The plant, however, is a native of tropical America where it is widely distributed. It is a perennial, 1-2 ft. high with erect and semi-erect round stems covered with short hairs and which root at the nodes especially if the upright stems are cut. The leaves are trifoliate, the terminal leaflet being larger than the two laterals. The leaflets are lanceolate in shape and measure $1\frac{1}{2}$-$3\frac{1}{4}$ in. long and $\frac{1}{2}$-$2\frac{1}{16}$ in. wide. A white irregular patch runs down the middle of each leaflet. The upper surface is dark green and is more pubescent than the underside. The flowers vary in colour from white to pink. The pods are 1-$1\frac{3}{4}$ in. long, in chains of 4-7 one seeded joints, hairy with indentations on both sides.

This legume has grown well at Peradeniya. It spreads quickly and forms a vigorous ground cover. Seed planted in October, 1951, at the Race-course Nursery, Peradeniya, produced plants which commenced to flower in June, 1952, and have produced flowers and seed continuously since then. It has a deep tap root and has withstood drought well.

(*b*) **Erect Covers**

(i) *Short bush plants.* These are the plants with an erect habit but only grow to a height of 1-3 ft.

Tephrosia purpurea Pers. (Singh. *pila* Tam. *kavilai*) is of value as an alternative crop to paddy in the dry zone where the water supply from the tanks that irrigate the fields is inadequate to grow a crop of paddy for the *yala* season. When this legume is to be first introduced into a field the seed should be sown mixed with the paddy at the rate of about 6 lb. per acre. As it possesses a hard seed coat it remains dormant during the growing season of the paddy and commences to germinate only after the harvest of the paddy. It forms a good cover throughout the dry season. Flowering and seeding take place in August and September and when the plants are turned

in as a green manure towards the end of September in the preparatory tillage operations for the sowing of the next crop of paddy, the self-sown seed remains dormant in the soil and germinates after the harvest of the paddy. The cycle of paddy and Tephrosia alternating with each other thus continues. The legume has a deep root system which renders it markedly drought resistant as well as useful in bringing up nutrients from the lower layers of the soil.

Phaseolus lathyroides Linn. (= *P. semi-erectus* L), the Phasemy wild pea, which is native to Tropical America and is probably an early introduction to India, Malaya and Ceylon grows wild in some of the paddy fields in the dry zone, generally after the paddy crop is harvested even though it appears with the standing crop of paddy in fields which are well drained and have little standing water. Like Tephrosia it can be used as a green manure crop in paddy land during the alternate season but the seed should be collected beforehand and sown prior to the harvest of the paddy before the soil becomes too dry. Some plants are affected by a mosaic disease of the leaves and seed should therefore be collected only from disease-free plants.

This legume grows erect to a height of 2-3 ft. and has trifoliate leaves developed on ascending branches which are covered with short hairs. The base of the plant tends to become somewhat woody. The leaflets are oblong ovate to oblong lanceolate, glabrous and measure $1\frac{1}{2}$-$2\frac{1}{2}$ in. long. The flowers are a purplish red about 1 in. long and are produced on erect racemes 10-20 in. long. The pods are 3-5 in. long and $\frac{1}{8}$ in. wide, nearly cylindrical and slightly curved, covered with small white hairs, and contain about 20-30 dark brown to grey, oblong seeds 1/8-3/16 in. long.

(ii) *Tall bush plants.* The plants in this group grow to a height of 3-10 ft. and become woody or semi-woody with age.

Crotalaria spectabilis Roth. (*C. sericea* Retz.) is a new introduction. Seed was obtained from the U.S.A. by the Tea Research Institute in 1950 and tried at St. Coombs, Talawakelle, and the Sub-Station at Passara. Some seed was sent for trial to Peradeniya and it has been found to grow well.

Although this legume is grown in the Southern States, particularly in Florida where it has spread as a wild plant, it was introduced from India where it is native. The seeds and entire plant are, however, poisonous to all stock (2).

A large quantity of green material is produced and from preliminary trials there is every indication of its being a useful bush green manure for lopping like C. *Brownei* Bertol.

The plants grow to a height of 4-6 ft. and produce simple, dark green, spathulate leaves measuring 4-6 in. long and 2-$3\frac{1}{2}$ in. wide, glabrous and lighter green on the under-surface. The flowers are yellow, about $\frac{3}{4}$ in. long, numerous and develop on erect terminal racemes about 1 ft. long on the main stem and in the axil of the upper leaves. The pods are light brown in colour, $1\frac{1}{2}$ in. long and 7/16 in. wide, glabrous and flattened on one side. The seeds are small, black and glistening.

This legume can be grown to advantage in contour hedges of newly opened land for planting rubber and tea and for established tea estates where there is no danger of browsing by livestock.

Sesbania speciosa Taub. ex. Engl. was first tried in 1930 with seed received through Kew from Kenya as a green manure for paddy (4). It was again introduced in 1946 from Madras where it was also originally obtained from Kenya—and once more in 1951. It is reported to be a valuable green manure for paddy fields in the Madras Presidency (9).

The plants grow to a height of 6-12 ft. and produce stipulate, imparipinnate leaves, 12-22 in. long with 20-30 pairs of nearly opposite leaves. The flowers are $1\frac{1}{4}$ in. long, bright yellow when open, but the outer sides of the vexillum are mottled with purple and this is the colouration of the flower before opening and after fertilization. About 16-20 flowers develop in pendent racemes in the axils of the upper leaves in $2\frac{1}{2}$-3 months time when the average height of the plants is about 3 ft. The pods are light brown in colour, 9-13 in. long and 1/3 in. wide with thickened sutures. Each pod contains 48-60 seeds and there are about 34,000 seeds to a pound. This legume has grown well at Peradeniya and several other stations in the wet and dry zones.

The Madras Department of Agriculture recommends (9) that the seed should be sown thinly on a raised and well manured seed bed. When 3-4 weeks old the seedlings should be transplanted 6 in. apart along the margins of some of the bunds of the fields about the same time that the paddy seedlings are transplanted or soon afterwards.

The plants are cut down and used as green manure during the preparatory tillage operations for the next crop of paddy. A few plants are left behind for seed purposes. Fresh seedlings should again be raised and the seedlings that are similarly planted out on the bunds with the second crop of paddy will provide the green manure for the following crop. Seed can also be sown at the rate of 10 lb. per acre in the standing crop sometime before harvest of the paddy and it is then cut down and turned in for the preparatory tillage operations of the next paddy crop. Trials are in progress on this system of growing the green manure on the bunds of the paddy fields and turning it in when the soil is being prepared for growing the next crop of paddy.

Several varieties of Toor dhal (*Cajanus cajan* (Linn.) Millsp.) are under trial at the Dry Farming Research Station, Maha Illuppallama, and they can be broadly separated into two main groups : the " seed " dhals and the " tree " dhals. The latter grow to a height of 6-8 ft. and do not seed or do so sparingly in the first year but in the second year seed production is normal. They are of great value in restoring soil fertility on arable land when grown for a period of two years or so on account of the heavy leaf fall and the deep root system which enables them to bring nutrients up from the lower layers of the soil. They are also for the latter reason markedly drought resistant. They are being tested in rotations for the same rôle that a grass ley plays in temperate countries in improving the fertility of the soil.

(c) High and Medium Trees

The trees in this group are grown for the purpose of providing green manure from the loppings and as shade for certain perennial crops. The well known trees are the Dadap (*Erythrina lithosperma* Blume ex Miq. and *E. indica* lam.), *Gliricidia sepium* (Jacq.) Steud., *Leucaena glauca* (linn.) Benth. and various species of *Albizzia*. Two more recent introductions are *Sesbania cinerascens*. Welw. from Southern Rhodesia and *Indigofera teysmanii* Miq. from Indo-China. The former has been tried on several tea estates and found to be a quick-growing tree which provides a light feathery shade. If lopped, it gives much green manure. It seeds well and is fairly wind-resistant. Seed can be planted direct in the field or seedlings may be transplanted from a nursery.

Indigofera teysmanii is another quick-growing tree in the wet zone but it tends to produce low branches unless planted in a close dense stand. This is a disadvantage when it is required as a shade tree for tea, cacao and coffee though as a routine operation the young shoots can be cut off.

Other species under trial are :—*Indigofera dosua* (= I. *stachyodes* Linde). *Erythrina poeppigiana* O. F. Cooke, *E. micropteryx* Poepp. ex Walp. and *Albizzia odoratissima* Benth.

II—FORAGE CROPS

These are grown as sole soiling crops as green feed or hay meals, as mixed soiling crops interplanted with fodder grasses, as components of pastures and as shrub browse plants.

(a) Sole Soiling Crops

In this group, the crops are grown in pure stand and are periodically cut for use as fresh fodder or after conversion to a hay meal.

(1) *Non-trailing ground covers.* Reference has already been made to the value of a new introduction in Spanish clover (*Desmodium uncinatum* (Jacq.) D.C.) as a green manure and soil protecting crop. Cattle and poultry readily consume the leaves. The crop can be grown for soilage and it stands cutting well.

Desmodium Sandwicense E. Mey. (=D. *limense*) (Fig. IV) and Stylo are of value, the former in both the wet and dry zones and the latter in the wet zone.

(2) *Trailing ground covers.* The two species which at Peradeniya have shown vigorous vegetative growth are *Psophocarpus palustris* Desv. and *Glycine javanica* Linn. They have also done well at the Livestock Station, Polonnaruwa, where they have been grown in observation plots and have been found to withstand the severe dry conditions which prevail there.

They can be propagated both from seed which is only produced between the months of November and February as well as cuttings. They are perennials and are readily eaten by cattle and poultry both as fresh feed

and as a hay meal. Codd and Myburgh (1) have pointed out the value of *Glycine javanica* in the warmer regions of South Africa both as a soil conserving as well as a fodder plant. They give the following analyses of the hay in comparison with velvet beans, *Dolichos lablab* and kudzu :—

Analyses of the hay on a moisture free basis :—

	Velvet Bean Percentage	*Dolichos lablab Percentage*	*Kudzu Percentage*	*Glycine javanica Percentage*
Protein	16·2	15·8	14·5	17·1
Crude fibre	34·0	43·3	30·0	36·6
Ether extract	1·8	1·5	2·4	1·4
Ash	10·8	8·8	12·8	12·8

The total digestible nutrients were found to be 51.07 per cent. for *Glycine javanica* hay as compared with 56.83 per cent. for lucerne hay.

(3) *Erect covers.* These are legumes which have an erect habit of growth. They may be short or tall plants.

Amongst the short bush plants *Phaseolus lathyroides* Linn. has possibilities in the dry zone where it grows wild. (loc. cit.). It is eaten both by cattle and poultry.

The thornless mimosa (*Aeschynomone Americana* Linn.) provides plenty of material for a soiling crop either fresh or after conversion into a hay meal (5). It has been successfully grown in the dry zone during the dry season at Hingurakgoda Station with periodic light irrigations.

It is of value as an alternative crop to paddy in the *yala* season in the dry zone where there is insufficient water in the tank for growing paddy. Several cuttings of highly nutritious fodder can be fed direct to cattle or as a hay meal in the ration to both cattle and poultry, provided the plants are cut when they are about 1-1½ ft. high and the stems have not become woody. As flowering and seeding take place during November to January, cutting should cease about the end of October or early November so that there may be sufficient growth before flowering commences.

Desmodium distortum (Aubl.) Macbride can like Thornless mimosa be grown in a pure stand for providing leafy material for feeding cattle, goats and poultry either as fresh green feed or in the case of poultry as a hay meal (6). It can be grown in the dry zone during the dry season as in the case of the Thornless mimosa with periodic light irrigations. The plants can be propagated from seed as well as from semi-woody cuttings. As some plants are susceptible to a mosaic disease seed or cuttings for propagation should be taken only from disease-free plants. Flowering and seeding take place during the months of September to March.

The " tree " dhals (loc. cit.) are also of value in providing forage to cattle and goats. Work is continuing at the Dry Farming Research Station, Maha Illuppallama, on the number of loppings and the quantity of forage that can be obtained each year from this type of dhal.

(4) *Fodder trees.* There is a large number of trees which can be used as fodder, particularly in the dry zone, where during the dry season little forage can be obtained from grasses and herbaceous legumes unless these are irrigated. There are also areas in both the dry and wet zones where the soil conditions are too poor for growing good pasture, but are adequate for supporting trees including those of fodder value.

Amongst the leguminous trees, *Leucaena glauca* (Linn.) Benth. is outstanding for drought resistance. Semple and Pendleton (7) have drawn attention to the use of this tree in feeding cattle and poultry. In the case of poultry, these authors quote Quisenberry and Draper who consider it inadvisable to feed the leaf meal to chickens at a concentration exceeding 5 per cent. of the ration as otherwise the health of the birds is affected. This legume is unsuitable for other non-ruminant animals such as pigs, rabbits and horses.

Plants can be raised from seed or from cuttings of 1-2 in. diam. They should be kept topped at a height of 3-4 ft. from the ground and the young shoots that develop thereafter can be lopped for the stock to feed on.

Another tree suitable for growing in the dry zone is the Algaroba bean or the Mesquite (*Prosopsis chilensis* (Mol.) Stunz.) which is a native of tropical America but has been introduced to the dry zone areas of several tropical countries. The leaves like Leucaena can be fed fresh or as a hay meal to cattle and poultry. The tender pods are also relished by cattle and can replace cereal grains in feeding poultry. The trees should be kept topped as in the case of Leucaena. They should not be allowed to grow uncontrolled as they are liable to spread and infest good grazing or arable land (6).

Sesbania grandiflora (Pers.)—Singh. *katurumurunga* Tam. *agati* is a common tree in village gardens in the wet lowland zone. The flowers are eaten as a salad and as a cooked vegetable and the tender leaves are also used in soups and *hodis*. Semple and Pendleton (8) have indicated the value of this tree as a browse plant for cattle and goats. The trees should be cut back to a suitable height. As they are not productive after 2-3 years growth, replanting should be practised.

The trees develop to a height of 12-20 ft. and produce long, pinnate leaves with 20-25 pairs of leaflets and large white fleshy flowers on pendulous axillary racemes. There is a less common variety with reddish flowers. The pods are long and pendent and as flowering and pod formation are continuous, seed is available throughout the year.

This is a legume which should be grown in every home garden as in Thailand.

(*b*) Mixed Soiling Crops

In this group are the legumes which are grown in mixture with other soiling crops such as the tall, tufted perennial grasses popularly referred to as fodder grasses. The two most important fodder grasses in Ceylon are

Napier (*Pennisetum purpureum Schum.*) and Guinea grass (*Panicum maximum* Jacq.) but hitherto they have been grown only in pure stand. The nutritive value of the cut fodder is increased by the legume component in the mixture, and the fertility of the soil is also improved through the presence of the nitrogen-fixing bacteria in the root of the legume. It is those legumes which are leafy and can withstand continual cutting back that are of most value. Those that have so far been found most suitable are—

Wet lowland and upland zones— (up to 4,000 ft.)
Stylo. (*Stylosanthes gracilis* H. B. & K.)
Centro. (*Centrosema pubescens* Benth.)
Desmodium Sandwicense E.MEY.

Dry lowland zone—
Centro.
Indigofera endecaphylla H. B. & K.

(*c*) **Pastures**

To a greater extent than in the case of fodder grasses, legumes should be grown in close association with pasture grasses. There are at present two areas where the pasture components differ, viz. : (*a*) The wet highlands (above an elevation of 4,000 feet.) and (*b*) all other zones—such as the wet and dry lowlands and the wet and semi-dry uplands. The following are the present recommendations as regards the legume components :—

(1) *The wet montane zone*—Red clover for the first year and white and subterranean clovers thereafter.

(2) *The wet lowlands and uplands—Stylosanthes gracilis* H. B. & K., *Indigofera endecaphylla Jacq.* and *Alysicarpus vaginalis* D.C. (*Singh. aswenna* Tam. *kuthiravalli*).

(3) *The dry lowlands—Indigofera endecaphylla* Jacq., *Alysicarpus vaginalis* D.C. and *A rugosus* D.C. (Tam. *Nama pundu*).

SUMMARY

Velvet beans have justified the earlier recommendation that this legume is drought resistant and has an important place in a scheme of rotational cropping in the dry zone as a cleaning and soil restorative crop.

Stylo in the dry zone is now badly attacked by the larvae of the Buprestid beetle and it is not considered profitable to grow it in a pure stand or mixed with grasses as a forage legume in that zone.

The Spanish clover was introduced in 1951 from Queensland and gives promise of being a valuable ground cover and forage legume.

Attention is drawn to the use of *Tephrosia purpurea* Pers. (*Pila* or *kavilai*) as a green manure on paddy land during the alternate dry season when there is insufficient irrigation water for cultivating paddy. Once introduced, Tephrosia will come up each season from self-sown seed after the harvest of the paddy.

Phaseolus lathyroides Linn. a hitherto neglected weed in the dry zone can be similarly used and also has potentialities as a pasture legume.

Crotalaria spectabilia Roth. like *C. Brownei* Bertol. is a useful bush green manure but it is poisonous to stock.

Interest is being revived in *Sesbania speciosa* Taub. ex Engl. which was first introduced in 1938 from Kenya, in view of the importance attached to it as a green manure for paddy fields in South India.

The Princess Bean and another species of *Psophocarpus* (viz. *P. palustris* Desv.) can be used to advantage by allowing the vines to grow up wire netting enclosures of poultry runs. Poultry feed on the leaves which can also be daily picked and given to the birds after shredding.

Thornless mimosa has been found to grow well in the dry zone with a few light irrigations. It is valued as a forage plant which can be cut several times like lucerne and fed fresh or after conversion to a hay meal.

Reference is made to green manure and shade as well as forage trees.

The need to grow legumes in mixture with fodder grasses for soilage is pointed out.

Finally, the legumes that have so far been found most suitable for pastures in the different zones are listed.

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Clinical Aspects of Gammexane Toxicity in Calves under Experimental Conditions

BY

P. JEGANATHAN

INTRODUCTION

GAMMEXANE, the gamma isomer of benzene hexachloride is widely used to control arthropod parasites of animals. In Ceylon it has proved very effective against several genera of ticks and mites. No case of toxicity due to this insecticide has yet been recorded in Ceylon.

Taylor and Frodsham (1946) had found no ill effects in rats, when the diet contained up to 13 per cent. gamma isomer of benzene hexachloride. According to Taylor (1945) two applications of 0.1 per cent. gammexane in liquid paraffin are more effective in rat mange and there were no signs of skin irritability at all.

Kirk (1946) reports that skin absorption can occur in cats giving toxic symptoms. According to this author, the most outstanding feature is the stimulation of the central nervous system. Blood *et al.* (1948) observed muscular twitching, opisthotonic convulsion and death in a Persian cat which was washed in 0.05 per cent. BHC.

In dogs Mc Namara and Krop (1948) have noticed blepharospasm, ataxia, tremor, clonic convulsion with urination, defecation and erection of hair as symptoms with Gammexane poisoning.

In cattle according to Mc. Enerney (1951) cited by Jolly (1952), accidental ingestion of Lindane (99 per cent. gamma isomer of Benzene Hexachloride) gave toxic symptoms in one hour. According to this author the animal staggered, salivated, collapsed and struggled on the ground. The neck was arched backwards, the animal paddled with the hind feet and died in four hours after the appearance of the symptoms.

At the Veterinary Research Laboratory, Peradeniya, a seven-month old Scindi heifer calf was brought with symptoms similar to those of meningitis. The animal showed a generalized clonic convulsion. Her temperature was 105° and respiration accelerated. There was a watery discharge from both the eyes and frothing from the mouth. The calf received two million units of Procaine penicillin and half an ounce of chloral hydrate in one pint of milk. Fifteen minutes after the administration of chloral

hydrate the calf progressively got over the convulsion but was hyperaesthic and showed muscular twitching all over the body. The following morning the calf was quite normal. On going through the full history of this case Gammexane poisoning was suspected and we decided to reproduce the clinical signs in some calves.

METHODS AND MATERIAL

The animals used in the experiments were 3 Scindi calves received from the Government Dairy, Undugoda

1. No. 104 .. Female Calf .. Born on 20.10.51
2. No. 115 .. Female Calf .. Born on 9. 1.52
3. No. 123 .. Male Calf .. Born on 22. 3.52

Gammexane (P520) containing 6.5 per cent. gamma BHC was used mixed in water in the following proportion :—

1. Solution A—6 ounces of Gammexane (P520) in one gallon of water (=0.04 per cent. gamma BHC). This is the proportion used for tick control work advocated by the Veterinary Research Laboratory, Peradeniya.
2. Solution B—One pound of Gammexane (P520) in one gallon of water (=0.65 per cent. gamma BHC).

PROCEDURES

Experiment 1

On August 14, 1952, at 8 in the morning all 3 calves were sprayed with solution A, using a bucket spray pump. Care was taken to wet the body completely. After spraying, the calves were kept in a pen for 15 minutes till the excess fluid was drained off. They were then transferred to another pen and muzzled to prevent them licking each other. The temperature, heart rate and respiration rate were taken before spraying and continued every two hours for four hours. The results are tabulated in Table I.

Table I

Time	*Animal's Number*	*Temperature*	*Heart beat Min.*	*Respiration rate Min.*
8 a.m.	No. 104	101·8°	64	40
	No. 115	102·8°	60	40
	No. 123	102·0°	68	44
10 a.m.	No. 104	102·0°	64	44
	No. 115	103·0°	64	44
	No. 123	102·2°	68	44
12 noon	No. 104	102·0°	64	44
	No. 115	103·0°	64	44
	No. 123	102·2°	68	44

None of the calves showed any toxic symptoms. They ate well, urinated and defecated normally.

Experiment 2

On September 4, that is about three weeks later, the above experiment was carried out with solution B. Within three hours toxic symptoms were noticed in one calf. An hour later the other two calves also showed similar toxic symptoms. The temperature, heart rate and respiration rate taken at two-hour intervals are tabulated in Table II.

Table II

Time	*Animal's Number*	*Temperature*	*Heart beat* Min.	*Respiration rate* Min.
8 a.m.	No. 104	102°	64	32
	No. 115	102·8°	60	36
	No. 123	102·6°	60	32
10 a.m.	No. 104	104°	68	36
	No. 115	104·6°	72	44
	No. 123	104°	64	32
12 noon	No. 104	104°	68	32
	No. 115	104·2°	72	40
	No. 123	104·2°	60	32

CLINICAL SIGNS

Calf No. 115

This calf showed symptoms of toxicity first. She looked dull in two hours from the time of spraying. She refused food, the eyes were closed and there was a watery discharge from them. The temperature was 104.6°, respiration rapid and heart rate increased. Half an hour later there were symptoms of ataxia, muscle tremor about the rump and shoulder region. There was intermittent opening of the eyes and with this the animal threw the head up. The frequency of throwing the head increased. There were then licking and chewing movements followed by frothing from the mouth. The respiration became deepened, laboured and more rapid. The animal started moving backward, then fell and went into a convulsion. At this time there was blepharospasm and the jaws were tightly closed. The convulsion lasted for 5 minutes and the animal progressively came to normal except for the muscular twitching. In 15 minutes she went into another convulsion. She had repeated attacks for nearly 6 hours with progressive increase of interval between two successive attacks. The following morning the animal started feeding and was back to normal.

Calf No. 104

This showed toxic symptoms an hour later than No. 115. The first noticeable clinical sign was a muscular tremor in the rump. The animal remained

standing. Her temperature was 104° and the respiration slightly accelerated. The tremor at the rump progressively increased to a generalized body tremor. In less than ten minutes the calf started running wildly in the pen, struck against the wall and fell. To prevent injuries two labourers held her. She made attempts to free herself, charged the labourers and started bellowing. She was given orally a sedative of $\frac{1}{4}$ oz. chloral hydrate in milk. When the sedative started acting the calf was left alone in a room with plenty of bedding. The following morning the animal was quite normal and was feeding.

Calf No. 123

The first clinical sign noticed was a rise in temperature to 104°. The animal was dull and remained lying down. He refused food and showed a mild tremor near the shoulder region. This calf did not show any other symptoms of toxicity. No treatment was given and at about 2 p.m. on the same day he started feeding normally.

DISCUSSION

When used as a spray, the recommended dose of 6 ounces of Gammexane (P520) in one gallon of water did not give rise to toxic symptoms in 6-8 months old Scindi calves. We still do not know the minimum dose that is necessary to produce toxic symptoms in calves of this age. But our observation shows that certain calves can develop hypersensitivity to this insecticide. Oral administration is not necessary to produce toxic symptoms in calves.

According to Short (personal communication) adult cattle can tolerate the strength of spray (0.65% gamma BHC) used by us on the calves to produce the clinical signs of toxicity. The degree of toxicity is inversely proportional to age, the youngest being most susceptible. As we did not include a sufficient number of calves we failed to observe this co-relation in our experiment.

With toxic doses the first noticeable clinical sign is a rise in temperature with increased heart rate. Respiration is usually accelerated but this is not a constant feature in all calves. The severity of symptoms varies with different calves. The most constant symptoms are dullness, discharge from the eyes, anorexia, ataxia and muscular tremors. In calves where the symptoms were severe there was blepharospasm, biting and chewing movements and convulsion.

From our observations we find that a spray containing 10 per cent. Gammexane water dispersible powder (P520) with a final content of 0.65 per cent. gamma BHC is not lethal to Scindi calves 6-8 months old.

Where Gammexane toxicity is suspected with nervous symptoms a sedative should be given. But Short reports that treatment of toxic signs is best given by intravenous calcium solution. According to him Barbiturates are useful in small animals but in adult cattle calcium alone is very effective.

SUMMARY

1. Toxic symptoms of Gammexane poisoning on skin absorption are given.

2. The severity of the symptoms varies in different calves.

3. The most constant clinical signs are a rise of temperature, increased heart beat, dullness, anorexia, ataxia and muscular tremor.

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DEPARTMENTAL NOTES

The Mild Cigar Tobacco Industry of Ceylon

BY

W. M. WIJERATNE

ACCORDING to available historical information tobacco was introduced to Ceylon in 1610 (1). As this date coincides with the Portuguese era in the Island, it is quite probable that this plant was one of their introductions. Jaffna was the pioneer in the industry, and it would have been a long period after that the hilly country adopted the cultivation of this plant, presumably at the time Portuguese infiltrations were experienced in these areas.

The mild cigar tobacco types grown in Ceylon, popularly known as Dumbara " Neti " and Dumbara " Kan " (petiolate and auriculate respectively) have confined themselves mainly to the Kandyan hilly regions.

The distribution of cultivation of these varieties of tobacco is as follows :—

	Acres
Kandy District—Teldeniya (Patha Dumbara)	700
Gampaha (Uda Dumbara)	600
Patha Hewaheta	700
Matale District—Matale South	400
Matale East	800
Matale North	1,400
Nuwara Eliya District—Uda Hewaheta	1,400
Kurunegala District	1,000
Total ..	7,000

The above are average annual extents. In practice, however, the extents vary considerably in each area from year to year according to fluctuations in demand and climatic conditions. Generally, there is a good demand for this type of tobacco for the manufacture of cheap brands of cigarettes, pipe-smoking tobacco, mild cigars and cheroots. The approximate annual requirement of this type of leaf for domestic consumption is in the region of 3,500,000 lb. The 7,000 acres under mild cigar varieties are able to produce this required quantity. In order to maintain and foster the cultivation of these types of tobacco marketing facilities have been provided to enable the cultivators to sell their produce direct to the manufacturers and thus avoid the exploiting middlemen.

In the areas enumerated above, tobacco is not cultivated as a crop in a regular rotation scheme. It is grown mainly by smallholders and peasant settlers in scattered blocks of 1/8 to one acre in extent in the majority of cases. The cultivation of this crop is done usually on hill slopes. It is not grown as a pure crop generally, but in a mixture with vegetables such as brinjal (*Solanum Melongenum*), bandakka (*Hibiscus esculentus*), and Chilli (*Capsicum*). This practice of mixed cropping has been continued mainly due to the dearth of land for food crops in these areas. Manuring of any sort is usually not resorted to by most of the cultivators. A few of the progressive type of farmers, however, practise the incorporation of cattle and green manure into the soil, when attempting to bring under tobacco a land recently cropped with other produce such as vegetables. Some cultivators who have cattle resort to tethering them on their tobacco lands prior to planting. The majority of farmers, however, practise the growing of tobacco in the Kandyan hilly areas as a form of shifting cultivation, quite akin to chena cultivation and essentially as a system of ley-farming.

After a season of tobacco, the land is utilized for obtaining a crop of kurakkan (*Eleusine coracana*) or mustard (*Brassica juncea*) and then abandoned for three to five seasons or even for 10 years in some cases.

At present efforts are being made by Government to educate these cultivators to adopt suitable rotations in preference to this wasteful method of cultivation.

Soil erosion on these undulating and hilly tracts of land where tobacco is cultivated is very severe, consequent to the shifting nature of cropping adopted. The construction of stone terraces and the opening up of storm water drains are some of the usual forms of soil conservation methods adopted by cultivators in the hilly areas. The methods resorted to by some growers have a tendency to intensify the rate of erosion rather than check it. The Government has at present taken up this subject, and arrangements are being made to help the peasant, in the adoption of the most suitable methods of soil conservation measures in relation to the different types of land cultivated.

Dumbara Cigar Tobacco is divided into three classes according to the purpose for which they are used in light cigar manufacture, viz., Filler, Binder, and Wrapper.

The filler is the chief component of the cigar, and the quality of the leaf which comprises it determines the strength, flavour and aroma. The binder holds the filler in place and contributes to retaining the shape of the cigar. The wrapper is the outermost covering which gives the desirable appearance to the cigar.

Each class has its own characteristic features which determine the purpose for which it is best suited. Heavy-bodied, aromatic and full-flavoured leaf are selected to form the filler. Medium bodied leaves lacking aroma and flavour are suitable for binder. Wrapper tobacco must be thin, elastic, grainy and flavourless. All classes of leaf must essentially have the capacity to burn freely, evenly, and with a white, compact ash.

All these three classes of leaf are being produced on the same plant in Ceylon. The wrapper from the lower leaves, the binder from those leaves immediately above the wrappers, and the filler from the uppermost leaves. In other countries, however, where the cigar tobacco industry has advanced very considerably and where large extents are brought under cigar tobacco varieties, it is a practice to grow a particular variety to produce the identical leaf class required for the manufacture of cigars. In Ceylon, however, on account of the limited demand for mild cigar type of tobacco, no such specialized production has been resorted to yet by growers. Further the above classification is required only by cigar manufacturers. The cigarette and pipe tobacco manufacturers, who are also purchasers of a considerably large quota of the output of cigar tobacco in the Island, have a different standard of grades for their requirements.

The requirements of tobacco for the manufacture of Jaffna cheroots are also quite different from those standards used by light cigar makers. For the Jaffna cigar the top leaf or " theruvi " is used for wrapper. The " oddusal " or centre leaf together with sand leaf and scrap are used for binder and filler.

The methods of cultivation and curing adopted by growers of Dumbara mild cigar tobacco in Ceylon are as follows :—

NURSERIES

After clearing and burning the scrub jungle in a 3, 5 or 10 year old abandoned block of land, a level area is selected usually in close proximity to a water supply. High jungle, if available, is even more suitable for the cultivation of this variety of tobacco. Level sites are usually selected for raising the required seedlings. A seed bed $3\frac{1}{2}'$ broad, $10'$ long, is normally sufficient to raise the required amount of seedlings for one quarter acre. Shallow drains round and between beds are provided to remove any storm water that may tend to run over the site during heavy rains. Well powdered dry goat manure or cattle manure is next applied to the beds. Thereafter the seed bed soil is well mixed up with the manure and a heap of brushwood is burnt on the bed for the purpose of sterilizing the soil. After the beds have cooled down, the ash left over is mixed up with the soil by means of a very shallow stirring up of the soil. The seed bed is next levelled and sown with seed selected from the previous season's cultivation; about half oz. of seed is sown mixed with fine sand and the bed is very gently pressed with the palm of the hand, to enable the seed to have a firm setting on the bed. A layer of straw is next strewn on the bed and a liberal supply of water given morning and evening till germination is observed after about 5-6 days. Thereafter, only moderate waterings are given twice a day for about 3 weeks. By this time the straw which would have been lifted up by the growing seedlings is removed and the seedlings are allowed to harden. Some

cultivators provide a raised cadjan shade for about a further week or two, if the weather conditions are too strong for the delicate seedlings. When the tobacco seedlings are about 6-8 weeks old, they are ready for transplanting.

PREPARATION OF LAND FOR PLANTING

Scrub jungle is felled in late January, and in mid-March burning and clearing of the land is undertaken. The stumps are removed and drains are opened at intervals of about 50 feet downwards and across the slope at a steep gradient. A few days before the seedlings are set in the field, planting hills are prepared. For this purpose small pits 1′ in diameter and 9″ deep are dug and the soil is removed. Thereafter these pits are filled with top soil around to form small mounds a few inches above ground level.

After having well watered the nursery beds earlier to avoid any damage to the small roots of the plants while uprooting, the tobacco seedlings are removed from the nurseries and transplanting is usually done in the evenings when the sun is not too strong. A small quantity of water is given per transplanted seedling immediately after setting it on the mound. On the following morning one more watering is given and the seedlings are covered with cocoa leaves or coconut husks as a shade against the sun. On the evening of the 2nd day a third watering is given and the seedlings are not given any further waterings normally till the rains are received. In most areas planting is done between mid-March and mid-April. Experienced cultivators usually plant up their fields before the Sinhalese New Year to enable the young seedlings to get established early to receive the full benefit of the Yala rains.

After the plants are well established, two to three intercultivations are given depending on the growth of weeds. At every weeding operation, earthing up of the plants is done along with the priming of sand leaf.

When the plants are about two months old the flower heads appear and at this stage " topping " or removal of the inflorescence is done leaving about 12 leaves on a well-grown plant. This operation is usually followed by the appearance of a number of suckers from the axils of the leaves. They are in turn removed on about three occasions at weekly intervals. Following the operations of " topping " and suckering the leaves of the plant begin to accumulate food and grow out into full development. Thereafter, the plant is allowed to remain in the field until all the leaves reach maturity. A few of the lower leaves generally ripen early and this development is observed even before the stage of topping. These leaves, termed " sand leaves ", are primed and cured on strings in sheds.

When the stage of full maturity is reached by the remaining leaves, the whole plant is cut and removed to curing sheds. The leaves are then removed with pieces of the stalk and stacked in a thin layer on the ground for about three days till the leaves develop a yellow tinge after the fermentation process. The leaves are then stuck on the cadjan walls of the shed with the pieces of stalk attached. They are allowed to remain in this condition

for about 21 days till they are fully dried. They are then bulked in heaps on platforms and covered with sacks for about a week. After this conditioning period the leaves are sorted into different grades as sand, middle and top leaves, and bundles of fifty are tied for easy handling. These bundles or " hands " are stacked in bulk and kept covered till final disposal. If the tobacco is not sold within a short period the heaps are broken and rebulking is done. The process of bulking the tobacco leaf promotes fermentation in the heap and thereby enables the leaf to become conditioned and develop a desirable aroma and texture.

During the period that curing is in progress the agents of the Jaffna cigar manufacturers usually visit the areas and make arrangements to purchase leaf. During the past 10-20 years, local cigarette tobacco manufacturers have also been absorbing a large quantity of this leaf for cheap brands of cigarettes and pipe tobacco mixtures. In very recent times the cigarette manufacturers have opened buying floors where fixed rates are paid to growers for the various grades. At present the rates paid by these manufacturers are :—No. 1 Re. 1/35, No. 2 Re. 1/15, and No. 3 -/85 cts. per lb. The Jaffna traders pay even up to Rs. 2/- for some of the best leaf. Their rates for the lower grade leaf are, however, far below those paid by cigarette manufacturers.

The economics of Dumbara cigar tobacco growing would work out as follows for an average farmer:—

COST OF PRODUCTION PER ACRE

	Items of Operation	*Cost Rs.*		*Items of Operation*	*Cost Rs.*
1.	Nurseries	15	9.	Hand watering ..	20
2.	Preparation of land ..	75	10.	Pest and disease control ..	5
3.	Draining and Soil Conservation work	25	11.	Priming	5
4.	Marking and holing ..	30	12.	Topping	5
5.	Transplanting	12	13.	Suckering	10
6.	Shading	8	14.	Erecting curing sheds ..	75
7.	Filling vacancies	5	15.	Harvesting, curing and bulking	80
8.	Intercultivation	40	16.	Land rent	40
				Total ..	450

AVERAGE RETURNS

1.	Yield per acre ..	.. 500 lb.
2.	Value per lb. ..	.. Re. 1·25
3.	Value per acre ..	.. Rs. 625
4.	Cost of production per acre	.. Rs. 450
5.	Net profit per acre ..	.. Rs. 175

The above are only average figures. There have been instances where higher net profits have been realized by experienced growers.

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Manual of Phytogeography by Leon Croizat

Dr. W. Junk, The Hague, 1952—587 pages, with 105 maps and 1 figure. Price : fl. 45

THE subtitle " AN ACCOUNT OF PLANT-DISPERSAL THROUGHOUT THE WORLD" explains the scope of the manual. It is composed of 12 chapters: I. Preliminaries, pages 11—44; II. The Concept of Genorheitron, pages 45-67; III.-VI. Intercontinental Dispersal, pages 68-399; VII. Epochs in Angiospermous Dispersal, pages 400-431; VIII. The significance of " Local " Dispersal, pages 432-473 ; IX. Non-angiospermous Dispersal, pages 474-511; X. Geography of the Past: A Phytogeographic Hypothesis, pages 512-525; XI. Phytogeography: Its purpose, methods and nature, pages 526-539: XII. Summary, pages 541-557. At the end of each chapter is a bibliography of publications referring to the subject-matter. At the end of the book is a Name and Subject Index, pages 558-587, followed by 105 full-page maps in black and white line drawings and a similarly done figure showing embryos of *Barringtonia Vriesei*. and young plants of *B. racemosa* and *Careya arborea*.

The main argument of Croizat's Manual is an application to a wide number of families and a few genera, of Lam's concept of *genorheithrum* (1938) (spelt *genorheitron* in the present work), and as such it is a most valuable publication. Croizat has critically considered and re-examined the facts of distribution in these cases and he finds a satisfactory explanation for their distribution in this concept, while he states that Willis' hypothesis of " Age and Area " " contained implicit at least the rudiments of orderly migration and *genorheitron*." It would be useful if in a future edition the author would consider Willis' recent contribution on the subject " The Birth and Spread of Plants " (1949).

The author welcomes constructive criticism, but as he gives his own reasons for following a particular course, it is rather difficult to comment. For instance, use of maps in the way he does. On page 8, he asks " What could I do to replace these maps with better ones? " One might answer, use one or other of the forms of Mollweide's projections instead of Mercator's, but his reasons show that although the adoption of this suggestion may convey a more accurate impression of the relative sizes of the land masses, it is not only not fundamental but even immaterial for conveying the author's idea of distribution.

In spite of the author's strictures on critics, as on page 534, a few incidental errors may be indicated, for future correction. While he rightly has *Erythroxylaceae* on page 194, on page 394 he wrongly uses *Podostemonaceae* for *Podostemaceae*. Again, he should adhere to the valid name *Careya coccinea* in place of *Careya arborea*, unless of course, he considers them to be distinct species!

Recent years have brought forth a few excellent books on " . . . . . that grand subject, that almost keystone of the laws of creation, Geographical Distribution. " Dr. Croizat's Manual, treating of distribution from a new angle, deserves wide circulation and is strongly recommended to all interested in the subject, for a fresh and invigorative outlook in phytogeography.

J. E. SENARATNE.

"Untaken Harvest" — Man's Loss of Crops from Pest, Weed, and Disease, by G. Ordish

Constable & Co., Ltd., London

THE losses to crops caused by insect pests and plant diseases are very lucidly demonstrated in this book. The estimation of these losses not only in terms of money but also in terms of wasted labour and land, both of which could normally be utilized for more constructive purposes, is a new approach, and serves very forcefully to impress the reader with the recurrent toll taken from agricultural crops by pests and diseases. The economic and social effects of pest and disease attacks are analysed in great detail. An informative chapter is devoted to a complete survey of modern methods available to combat losses caused by pests and diseases. A section dealing with the present and future of crop protection, while pointing out that the greater part of the world's food supply is produced in peasant holdings, gives a clear analysis of the reasons for persistent crop losses in spite of the availability of, in most cases, very effective scientific measures for avoiding such losses. Emphasis is laid on more education and extension for the peasant farmer and the development of co-operative interests and action in peasant holdings as a solution to recurrent crop losses which are due chiefly to ignorance or financial handicaps or both, on the part of the farmer. The book is concluded by a brief though instructive chapter on the history of the trade in insecticides which are today the cheapest and, in the majority of cases, the most effective weapons we have against pests and diseases. Both to those who have the interests of better agriculture at heart and define major agricultural policies and to those who are involved in translating these policies into practice on the field, *Untaken Harvest* should provide a sounder perspective of the problems at hand and of the pressing need for avoiding waste of valuable food, labour and land, which in the final analysis would appear to be financed and maintained for the survival and subsistence of insect pests and plant diseases and not for man, as it *should* be today when politicians and scientists alike are preoccupied with the subject of world food demands.

H. E. Fernando.

Government Notifications

Paddy Lands Act, No. 1 of 1953

L.D.—O. 35/48.

AN ACT TO REGULATE THE LETTING OF PADDY LANDS IN ORDER TO ENSURE GREATER SECURITY OF TENURE TO THE TENANTS OF SUCH LANDS; TO RESTRICT THE RENT RECOVERABLE FROM SUCH TENANTS; TO EMPOWER THE PROPER AUTHORITY TO TAKE POSSESSION AND CAUSE THE CULTIVATION OF ANY SUCH LANDS WHICH ARE NOT CULTIVATED; AND TO PROVIDE FOR MATTERS INCIDENTAL TO OR CONNECTED WITH THE MATTERS AFORESAID.

[Date of Assent: February 13, 1953]

BE it enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Senate and the House of Representatives of Ceylon in this present Parliament assembled, and by the authority of the same, as follows:—

Short title.

1. This Act may be cited as the Paddy Lands Act, No. 1 of 1953.

Application of Act.

2. (1) This Act shall apply to and in relation to all paddy lands situated in any such area as may be declared by Order of the Minister to be an area in which this Act shall be in operation:

Provided however that the Minister may, by the same or a subsequent Order, exempt any specified paddy land, or paddy lands of any specified class or description, from all or any of the provisions of this Act.

(2) Every Order made under sub-section (1) shall be published in the *Gazette* and shall come into force on the date on which it is so published or on such later date as may be specified in the Order.

Controlled paddy lands.

3. In this Act, the expression "controlled paddy land" means a paddy land or any undivided share thereof situated in an area in which this Act is in operation, other than a paddy land exempted as hereinbefore provided from all the provisions of this Act.

Leases, and changes in ownership of controlled paddy lands.

4. (1) No person shall let a controlled paddy land for a period less than five years and no tenancy of a controlled paddy land for a period less than five years shall be valid;

Provided however that, where on the day immediately preceding the date on which this Act becomes applicable to a paddy land there is in respect of that land a valid tenancy which but for the preceding provisions of this sub-section would continue to be valid for any period after that day, such provisions shall not apply to that tenancy during a period of three hundred and sixty days commencing on that date.

(2) A lease of a controlled paddy land for a period not less than five years may be created by a writing—

(*a*) signed by the lessor, and the lessee or by some persons lawfully authorised in writing by them, in the presence of two witnesses present at the same time,

(*b*) attested by such witnesses, and

(*c*) stating—

(i) the name and address of the lessor and the capacity in which he effects the lease,

(ii) the name and address of the lessee,

(iii) the name, extent, situation, and boundaries of such land and the names of the co-owners if any,

(iv) the date of commencement and the date of termination of the lease,

(v) whether the tenancy is an *ande* tenancy or not,

(vi) whether the authorised rent of such land is to be paid in paddy or in money,

(vii) the intervals at which such rent is to be paid, and

(viii) the date of execution of the lease.

The provisions of section 2 of the Prevention of Frauds Ordinance shall not apply to a lease created in accordance with this sub-section. Cap. 57.

(3) A writing whereby a lease of a controlled paddy land for a period not less than five years is created in accordance with the provisions of sub-section (2) shall, if the particulars which are required by that sub-section to be set out in such writing are registered as hereinafter provided in the register of controlled paddy lands of the revenue district in which the paddy land is situated, be deemed for the purposes of section 7 of the Registration of Documents Ordinance to be an instrument duly registered under that Ordinance and affecting the land described in such writing. Cap. 101.

(4) Where a lease of a controlled paddy land for a period not less than five years is executed, the lessor shall forthwith in writing notify the lease to the proper authority of the revenue district in which that land is situated, stating the particulars of the matters specified in paragraph (*c*) of sub-section (2); and if such lease is cancelled, the lessor and the lessee shall forthwith in writing notify the cancellation to such proper authority, stating the date on which the cancellation takes effect.

(5) Where a change occurs in the ownership of a controlled paddy land, the new owner shall, within thirty days of such change, give written notice thereof to the proper authority of the revenue district in which that land is situated.

Authorised rent of controlled paddy lands.

5. (1) For the purposes of this Act the authorised rent per annum of a controlled paddy land shall be—

(*a*) such quantity of paddy obtained from that land as represents the prescribed landlord's share of paddy, or

(*b*) where the lease requires the rent to be paid in money, the monetary value of that quantity of paddy calculated at the prescribed rates of valuation of paddy ;

and the authorised rent of that land for any portion of a year shall be proportionately determined.

(2) Regulations made for the purposes of this section may prescribe for different areas—

(*a*) different percentages or quantities of paddy as the landlord's share of paddy, and

(*b*) different rates of valuation of paddy.

Prohibition of rent exceeding authorised rent.

6. No person shall demand, receive or recover as the rent of a controlled paddy land an amount exceeding the authorised rent of that land:

Provided however that, where on the day immediately preceding the date on which this Act becomes applicable to a paddy land there is in respect of that land a valid tenancy which but for the preceding provisions of this section would continue to be valid for any period after that day, such provisions shall not, during a period of three hundred and sixty days commencing on that date, apply in relation to the rent chargeable under that tenancy.

Prohibition of any payment in addition to rent.

7. No person shall, as a condition of the grant, renewal or continuance of the tenancy of a controlled paddy land, demand or receive, in addition to the rent of that land, any premium, commission, gratuity or other like payment or pecuniary consideration.

Returns.

8. (1) In each year, on or before the prescribed date, the owner or lessee of every controlled paddy land shall furnish a return, in respect of that land, in the prescribed form and containing particulars of the prescribed matters, to the proper authority of the revenue district in which that land is situated.

(2) Where a land, which is not a paddy land and which is situated in an area in which this Act is in operation, is converted into a paddy land, the owner or lessee thereof shall, within two weeks before the first sowing of

paddy thereon, furnish a return, in respect of that land, in the prescribed form and containing particulars of the prescribed matters, to the proper authority of the revenue district in which that land is situated.

(3) The proper authority of a revenue district may, by written notice, require the owner or lessee of a controlled paddy land in that district to furnish to him, within such time as may be specified in the notice, particulars of such matters relating to that land as may be so specified.

(4) Where a notice under sub-section (3) is sent to the owner or lessee of a controlled paddy land, he shall comply with that notice within the time specified therein.

Registers of controlled paddy lands.

9. The proper authority of a revenue district in which there are controlled paddy lands shall keep and maintain a register of those lands in the prescribed form. He shall cause to be entered in such register particulars of such matters relating to those lands as may be prescribed and such particulars as may be notified to him under section 4.

Restriction on actions for ejectment of tenants of controlled paddy lands.

10. (1) Notwithstanding anything in any other law, no action or proceedings for the ejectment of the tenant of a controlled paddy land shall be instituted in or entertained by any court, unless the proper authority of the revenue district in which that land is situated has, on the application of the landlord of that tenant, sanctioned in writing the institution of such action or proceedings.

(2) Before the proper authority grants or refuses sanction for the institution of any action or proceedings for the ejectment of the tenant of a controlled paddy land, the proper authority, or any officer authorised in that behalf by the proper authority, shall hold an inquiry into the question why the landlord of that tenant desires to eject him from that land and shall allow the landlord and the tenant to adduce such evidence at the inquiry as the proper authority or the officer so authorised considers relevant.

(3) Where an inquiry relating to the tenancy of a controlled paddy land is held under sub-section (2), the proper authority of the revenue district in which that land is situated may invite any two members of the District Agricultural Committee, constituted for that revenue district, to be present and assist him, or the officer authorised by him to conduct the inquiry, in his or that officer's deliberations at the inquiry.

(4) The proper authority shall sanction the institution of any action or proceedings for the ejectment of the tenant of a controlled paddy land if he is satisfied that—

(*a*) the rent in respect of that land has been in arrear for one month after it has become due, or

(*b*) where the tenancy of that land is an *ande* tenancy, the tenant has, for the purpose of determining the authorised rent of that land in respect of any period, fraudulently declared as the crop from that land a quantity of paddy which is less than the actual quantity of paddy obtained from that crop, or

(*c*) the tenant has given notice to quit, or

(*d*) the condition of that land has deteriorated owing to acts committed by, or owing to the neglect or default of, the tenant.

Time of commencement of cultivation in each season.

11. (1) The proper authority of any revenue district in which controlled paddy lands are situated may specify, in respect of each season, a date on or before which operations for the cultivation of such lands shall commence. Different dates may be specified for such lands situated in different parts of such district.

(2) The proper authority of any revenue district shall cause notice of every date specified by him under sub-section (1) to be given, in such manner as he may deem adequate, throughout that district or any part thereof to which such date applies.

(3) The proper authority of any revenue district may at any time, if it appears to him expedient so to do, by notice given in the manner provided in sub-section (2), cancel any notice previously given by him under that sub-section and specify a later date on or before which operations for the cultivation of controlled paddy lands situated in that district or any part thereof shall commence.

Proper authority's power to take possession of controlled paddy lands.

12. (1) Where the proper authority of any revenue district is satisfied that operations for the cultivation of any controlled paddy land situated in that district have not commenced in any season on or before the date specified under section 11, he may take possession of that land and adopt such measures, and use such force, as he may deem necessary for the purpose of taking such possession.

(2) In any case in which the proper authority is empowered by sub-section (1) to take possession of any controlled paddy land, he may, before taking possession of that land, call upon the owner of that land and, where there is a lessee of that land, such lessee to show cause why the proper authority should not take possession of that land, and, where such owner or lessee shows cause which appears to the proper authority to be adequate, the proper authority may refrain from taking possession of that land if such owner or lessee enters into a written undertaking to the satisfaction of the proper authority to comply with such terms and conditions as the proper authority may think it necessary to impose in order to secure the proper and regular cultivation of that land with paddy.

(3) Where the proper authority is satisfied that there has been a breach of any undertaking entered into by the owner or lessee of a controlled paddy land under sub-section (2), the proper authority may, without prejudice to any other right conferred on him by the undertaking, take possession of that land and adopt such measures, and use such force, as he may deem necessary for the purpose of taking such possession.

Restoration of possession.

13. (1) Where the proper authority has taken possession of any controlled paddy land under section 12, he may at any time restore possession of that land to its owner or lessee if he is satisfied that the owner or lessee will cause that land to be properly and regularly cultivated with paddy.

(2) The restoration of possession of a controlled paddy land to its owner or lessee under sub-section (1) shall not affect or prejudice the power of the proper authority to take possession of that land under section 12.

Proper authority's duties in respect of controlled paddy lands taken over by him.

14. (1) Where the proper authority has taken possession of any controlled paddy land under section 12, he shall—

(*a*) issue to the owner or lessee of that land a certificate in writing under his hand that he has taken possession of that land for the purpose of causing it to be cultivated with paddy,

(*b*) cause that land to be cultivated with paddy by such person or persons as he may deem fit, during such number of seasons as he may in his discretion determine, and

(*c*) during the continuance of such possession, pay the authorised rent of that land to its owner or lessee.

(2) The proper authority shall cancel the certificate issued under sub-section (1) in respect of any controlled paddy land if possession of that land is restored to its owner or lessee under section 13.

Notices.

15. A notice under this Act shall be deemed to have been sent to any person if it had been transmitted through the post by registered letter addressed to him at his last known place of abode.

Regulations.

16. (1) The Minister may make regulations for giving effect to the provisions of this Act.

(2) In particular and without prejudice to the generality of the powers conferred by sub-section (1), the Minister may make regulations in respect of all matters stated or required to be prescribed.

(3) No regulation made by the Minister shall have effect until it has received the approval of the Senate and the House of Representatives and until notification of such approval has been published in the *Gazette*.

Offences.

17. Every person who contravenes or fails to comply with any of the provisions of this Act or of the regulations made under this Act shall be guilty of an offence and shall, on conviction after summary trial before a Magistrate, be liable to a fine not exceeding five hundred rupees, and, in default of payment of a fine, to imprisonment of either description for a term not exceeding one month.

Prosecutions.

18. A prosecution for an offence under this Act may be instituted by the proper authority or an officer authorised in that behalf by the proper authority.

General directions of the Director of Food Production.

19. The proper authorities shall, in the exercise of their powers and the discharge of their duties under this Act, be subject to the general directions of the Director of Food Production.

Interpretation.

20. (1) In this Act, unless the context otherwise requires—

"District Agricultural Committee" means a District Agricultural Committee constituted under the Irrigation Ordinance, No. 32 of 1946;

"let" includes "sub-let", and its grammatical variations shall be construed accordingly ;

"paddy land" means land prepared for the cultivation of paddy, but does not include chena land or land not provided with earth bunds to impound water ;

"prescribed" means prescribed by regulation made under this Act ;

"proper authority", with reference to any revenue district, means the Government Agent, an Additional Government Agent, an Assistant Government Agent, or an Additional Assistant Government Agent of such district, or any prescribed officer ; and

"*ande* tenancy" means the tenancy of a paddy land under which the tenant undertakes to give as rent a share of the paddy crops of that land to the person who let that land.

(2) Where the owner or lessee of a controlled paddy land and a cultivator of that land who has no right of ownership or leasehold in respect thereof are each entitled to a share of the paddy crops of that land, such cultivator shall, for the purposes of this Act, be deemed to be the tenant of that owner or lessee under an *ande* tenancy in respect of that land and not a worker hired by that owner or lessee to cultivate that land.

MEETINGS

PROCEEDINGS OF THE INAUGURAL MEETING OF THE CENTRAL BOARD OF AGRICULTURE, HELD IN THE BOARD ROOM AT THE ROYAL BOTANIC GARDENS, PERADENIYA, ON NOVEMBER 25, 1952

Senator The Hon. Sir Oliver Goonetilleke, K.C.M.G., K.B.E., Minister of Agriculture and Food, presided and the following were present:—

Mr. K. Somasuntharam, C.C.S., Permanent Secretary to the Ministry of Agriculture and Food; Dr. A. W. R. Joachim, Director of Agriculture (Chairman); Mr. C. A. M. de Silva (Vice-Chairman) ; Mr. A. Hensman ; Mr. Vernon Rajapakse ; Gate Muhandiram Arthur D. S. Jayasinghe; Mr. N. R. Rajavarothiam, J.P.; Mr. W. M. Cumaraswamy; Mudaliyar S. Armstrong; Major E. C. de Fonseka, M.B.E., E.D.; Mr. A. D. Paranavithane ; Mr. S. L. Bandara Dharmakirti ; Mr. C. Wijesinghe ; Mr. D. G. Dayaratna, C.C.S., Director of Rural Development ; Dr. M. L. M. Salgado, Acting Director, Coconut Research Institute ; Mr. S. C. Fernando, C.C.S., Registrar of Co-operative Societies (representing the Commissioner of Co-operative Development) ; Mr. S. Pathmanathan : Mr. R. H. de Mel ; Mr. S. Pararajasingham ; Mr. S. Vytilingam, M.P., Mr. A. F. R. Gunawardena ; Mr. R. H. Spencer Schrader ; Mr. E. Muttukumaru ; Mr. A. M. Clement Dias ; Mr. S. M. Rasamanickam, M.P., Mr. H. Abeywickreme, M.P., T. B. Poholiyadde Dissawe, M.P. ; Dissawe H. B. Rambukwella, M.P., Senator Lady Molamure ; Mr. S. Sivapalan ; Mr. Marcus S. Rockwood ; Mudaliyar N. M. Abulcassim Marakar ; Mr. R. Singleton Salmon, M.P., Mr. J. Lamb, Director, Tea Research Institute ; Mr. A. T. Sydney Smith ; Mr. K. Morford ; Sir James P. Obeysekera ; Mr. K. W. Devanayagam ; Mr. A. Perumynar ; Mr. T. B. Naranpanawa ; Mr. S. A. I. Elapata, M.B.E., J.P., U.M.; Mr. F. A. Wickremasuriya ; Mr. P. B. Bandaranayake ; Mr. Gladwin C. H. Kotalawala ; Mr. N. Manicka Idaikkadar, C.C.S., Director, Food Production ; Mr. B. L. W. Fernando, Acting Commissioner for Development of Marketing ; Mr. L. S. B. Perera, C.C.S., Land Commissioner ; Senator Miss Cissy Cooray ; Mr. N. H. Keerthiratne, M.P. ; Mr. Anton C. Ponnambalam ; Mr. R. T. Chelliah ; Mr. W. T. I. Alagaratnam, Director of Irrigation ; Mr. L. S. Boys ; Mr. S. A. Selvanayam ; Mudaliyar M. M. Ibrahim, M.P. ; Mr. Albert Godamune ; Mr. C. B. Nugawela ; Mr. M. B. Samarakoon ; Mr. M. Senanayake, M.P.; Mr. U. B. Dedigama ; and Dr. W. R. C. Paul, Assistant Director of Agriculture (Technical) officiating as Secretary in the absence of the Secretary Mr. M. Sivanathan, C.C.S., Assistant Director of Agriculture (Administration).

The following visitors were also present:—Mr. H. Hirst, F.A.O.; Adviser in Animal Husbandry : Mr. C. N. E. J. de Mel, Deputy Director of Agriculture ; Mr. J. Byde Martin ; and Mr. A. V. Richards, Horticultural Officer.

Letters and telegrams regretting inability to attend the meeting were received from the following:—Mr. G. K. Newton ; Mr. Thomas Amarasuriya ; Gate Mudaliyar N. Wickremaratne ; Mr. Wilmot A. Perera, M.P.; Sir Wilfred de Soysa ; Mr. M. Srikhanta, C.C.S., Director of Land Development ; Gate Mudaliyar M. S. Kariapper ; Mr. A. N. D. A. Abeysinghe, M.P.; Mr. U. B. Unamboowe, M.P.; Mr. S. H. Mahadiulwewa, M.P.; Mr. K. Kanagaratnam ; Mr. T. C. Rajaratnam ; Mr. H. S. Hurst ; and Mr. Sydney Ellawala.

I.—CONFIRMATION OF THE MINUTES OF THE LAST MEETING

The minutes of the last meeting of the Central Board of Agriculture were unanimously confirmed.

II.—VOTE OF CONDOLENCE

In passing a vote of condolence on the death of the late Prime Minister, the Rt. Hon. D. S. Senanayake, the Chairman (Dr. Joachim) said " We have received a severe blow in the loss of our late lamented Prime Minister, the Rt. Hon. D. S. Senanayake. He was the one who first re-constituted the Board of Agriculture in the form that it is more or less at present. It was he who encouraged the people of our country to express their views and opinions on matters relating to the agricultural development of the country and these views always received his sympathetic consideration. Before I proceed further I would ask you Gentlemen to stand in memory of a great man who has done so much for this Island of ours ".

III.—CHAIRMAN'S WELCOME TO THE HONOURABLE THE MINISTER OF AGRICULTURE AND FOOD AND THE MEMBERS OF THE BOARD

Chairman—" Honourable Minister and Members of the Board,—It is my privilege today to welcome you here, Sir, to this inaugural meeting of the newly constituted Board of Agriculture, and you Gentlemen I welcome to this Board, some of you not as strangers, but others as newcomers, as experienced agriculturists ready to contribute your best by way of information and advice towards the solution of the problems of Food Production in this country.

This is our inaugural meeting of the new Board. The last Board met about January this year but since then many changes have occurred. We have a new Government, we have had a re-shuffle in the way of administration within the Government and today we have a new Ministry of Agriculture and Food headed by the Honourable Sir Oliver Goonetilleke whom we have here to welcome you to encourage us, and to co-operate with us in the great work which has been entrusted to him (*Applause*). Sir Oliver as you know is a dynamic personality. He is a ' go-getter ' who gets things done, and only those in close contact with him such as my Permanent Secretary, Mr. Somasuntharam, really know what it is to work with a person like him who means really to do something for the benefit of this country. It means that we too are kept on our toes all the time, but it is a great encouragement to know that he does appreciate whatever is done towards fulfilling the objectives which we all so ardently desire.

We have also a new Prime Minister who was the Minister of Agriculture and Lands under the old Government. I think it is only appropriate that we should take the opportunity, and I wish to do so on behalf of this Board, to offer him our congratulations and good wishes for the success of his regime (*Applause*). Well, Gentlemen, I do not want to delay the proceedings of our deliberations of this meeting further.

As you know, those of us who have been members of the previous Board, know that this is a greatly enlarged Board of Agriculture. That is due to the fact that our Minister feels that every man who can make a contribution towards the solution of this problem is welcome to do so and that is why he feels that numbers do not make any difference when it comes to a matter of such vital importance. We are therefore glad to have you here and I am sure that you could make a valuable contribution towards our discussion. I know that whatever

views you express, whatever decisions we may arrive at, will always receive the careful attention and careful consideration of the Ministry in charge of Food Production, and Sir Oliver will be the first I know to give every consideration to our discussions and proposals.

Now it has to be mentioned here that we are an Advisory Board. We are not an executive Board. It is our function to tender advice and suggest proposals for the agricultural advancement of the country to the Ministry for its consideration. This, in the past, we have done by way of resolutions brought up by individual members. But it is proposed in this Board to extend the scope of our discussions and to make them wider than what has been the case in the past. For instance it is most appropriate that we should have a full discussion on Food Production so that we can get the views of all the members who can make any contribution towards this end. While, therefore, in future we shall welcome individual resolutions from members, we would rather prefer to discuss general matters relative to the agriculture of the country so that this information could be disseminated to the people who are most intimately connected with its development and cultivation. Our function also as a Board is to advise and report to the Ministry on any matters referred by it for our consideration. There are matters of importance on which the Minister himself would like advice from us. Such matters he would, through his Permanent Secretary refer to us for our consideration, and we would have to tender him such advice as we deem appropriate. There is nothing, however, to prevent us individually and collectively expressing views and opinions and making suggestions for the development of agriculture and particularly of food production in the country.

There are certain changes which will be proposed for your consideration during the discussion when that item is taken up, but I do want to refer to it here. For example we had in the old Board what was known as an Executive Committee. Now it seems rather incongruous that we should have an Executive Committee of an advisory Board. I think that, some consideration should be given to this point and we shall have to make a change in that respect. This matter would be taken up when we discuss the Rules of the Board. Without saying much more, therefore, I will conclude, once again, Sir, thanking you for having come here to encourage us and help us along to help you in the solution of these problems. Once again I offer you gentlemen a hearty welcome. I am sure your deliberations will really be fruitful in many ways towards the establishment of a concentrated and better agriculture.

The Honourable Minister suggests that we should first discuss the items on the agenda and, thereafter, he would be pleased to address the Board. Following this we propose to have a general discussion on any matters relating to subjects which he shall touch on in the course of his speech."

IV.—ADOPTION OF RULES

The Chairman read out the Rules first and invited any amendments members would like to propose.

It was agreed that the following amendments to the Rules of the previous Board should be made:—

The words " at least " were added to Rule No. 1 to read thus—

(1) The meetings of the Board shall be held at least four times a year or on any special occasion as may be desired in writing by not less than 15 members of the Board or by the President.

Rule No. 2, the word " leave " was substituted by the word " intimation ". It read thus—

(2) Every member of the Board who has been absent for three consecutive meetings during his tenure of office without intimation or if his absence was not due to ill-health shall be considered to have vacated his seat.

Rule No. 3, the word " eighteen " was substituted by the word " twenty " to read—

(3) At meetings of the Board twenty members shall form a quorum. The Chairman preferred Rule No. 4 to be deleted as the casting vote of the Chairman should not determine a decision arrived at by members of an advisory body. A majority of the members. however, wished this rule to be in force and it was adopted accordingly.

(4) At each meeting the Chairman shall have an original vote, and in the case of an equality of votes he shall have an additional casting vote.

Rule No. 5, the word " thirty " was substituted by the word " fifteen " to read—

(5) Fifteen days at least before the date of a meeting of the Board, the Secretary shall post a notice of the meeting to each member of the Board. Notice of any subjects that a member may desire to be placed on the agenda of any meeting shall reach the Secretary ten days at least before the date appointed for the meeting.

Rule No. 6 was adopted without amendment to read—

(6) The agenda of a meeting shall be posted by the Secretary to the members at least seven days before the date fixed for the meeting.

Rule No. 7 was adopted without amendment to read—

(7) It shall be the duty of the Secretary to keep a proper record of the minutes of each meeting of the Board.

Rule No. 8 was adopted without amendment to read—

(8) The meetings of the Board shall be open to the Press unless otherwise decided by the Board.

Rule No. 9 was adopted without amendment to read—

(9) At a General Meeting of the Board rules may be amended or new rules adopted with a majority of two thirds of the members of the Board present and voting at such meeting.

At this stage the Chairman introduced the following as a new Rule and the Board unanimously agreed to its adoption:—

" There shall be appointed the following Standing Committees of the Board:—(1) Resolutions Committee
(2) Food Production Committee
(3) Animal Husbandry Committee
(4) Plantation Products Committee."

The Chairman stated that it was very desirable that the Board should have the above-mentioned Standing Committees to which in the first instance any matter relating to that particular subject may be referred for deliberation and discussion before it came to the general

Board. He added that in the old days there were two Standing Committees of the Board known as the Estates Products Committee and the Food Production Committee respectively. Those Committees met separately and discussed matters relating to their subjects and they were very productive of results. They dealt with details which the general Board did not deal with. The practice in the recent past was to appoint ad-hoc committees to discuss any particular matter, e.g., in the previous Board a Committee was appointed to go into the question of extending vegetable cultivation in the Island. That Committee produced a very valuable report, but unfortunately this could not receive the attention of the Board because it was submitted at the last meeting of the Board. Another Sub-Committee the last Board appointed was the one which went into the question of Crop and Cattle Insurance. That did very valuable work. Committee No. 1 (Resolutions Committee) he said would not have much work to do except to examine resolutions submitted to the Board and approved by it. In conclusion he said that it was very desirable to have those Committees appointed instead of ad-hoc committees. He requested members to communicate with the Secretary and indicate on which Committee they would like to serve.

The Chairman suggested that if the meeting of the Board was to be held in the afternoon, the Committees could meet in the morning of the same day.

The Chairman announced the Chairman to each of these Committees. The Deputy Director (Animal Husbandry) would be Chairman of the Animal Husbandry Committee; the Director, Food Production, would be Chairman of the Food Production Committee; as regards the Plantation Products Committee, he himself would be Chairman.

V.—ELECTION OF VICE-CHAIRMAN OF THE BOARD

Mr. C. A. M. de Silva's name was proposed by Mr. Gladwin C. H. Kotalawala and seconded by Mr. P. B. Bandaranayake for the office of Vice-Chairman.

There being no other names, Mr. C. A. M. de Silva was duly elected Vice-Chairman of the Board.

Mr. C. A. M. de Silva thanked the members for having returned him to be Vice-Chairman of the Central Board of Agriculture. He said he was happy and proud of the fact that members had shown appreciation of his work as Vice-Chairman of the last Board.

Sir Oliver Goonetilleke, K.C.M.G., K.B.E., Minister of Agriculture and Food addressed the Board next.

" Mr. Chairman, Ladies and Gentlemen,—it cannot but be a very great pleasure to one who is privileged to be Minister of Agriculture to face a Central Agricultural Board in such numbers as I see in front of me this morning. I was especially anxious, as the Chairman has explained to you, that the composition of this Board should be so widespread that it should be at least a symbol of the great leadership that we have seen in matters agricultural in this country during the last two decades. There are not a few in this room whose recollections of the opening of these meetings with the Governor of the Colony as Chairman must still be very vivid. There are others who are probably attending these meetings for the first time. I should like to express my special gratification that two ladies have agreed to serve on this Board. I shall explain later on why I thought it an advantage to have them here, but it is sure to be that, when one attempts to hand-pick people as I have done to serve on this Committee, I have left out of consideration a great number

who should be given an opportunity of joining us at an early date. I would welcome any suggestions that you would like to make from time to time to your Chairman so that those who can help and those who want to help may not be prevented from joining us. I think we meet this morning at a period of our history that is full of urgent matters. Your Chairman referred to the passing away of our great leader and I think his own achievement in the field of agriculture constitutes the starting point from which we have to face the problems of the days ahead. I do not think that any Minister of Agriculture has had the privilege of stepping on to such a volume of achievement as I have. This achievement was from what was started by the late Mr. D. S. Senanayake and completed and implemented by his worthy son, but this very achievement imposes, I submit, a responsibility on me and on you which almost looks difficult to carry at the moment. I should like to enlarge on this. It is not an achievement of actual volume in acreage. It is primarily an achievement of all the hard work that is indispensable for any well-planned, orderly, agricultural extension. I submit to you, Mr. Chairman and all others in this room who are better qualified than I to pass an opinion, that most of the items of work which are not possible to rush in agriculture, have been fairly achieved. Let me explain further. Take the field of paddy production. We do happen to know, owing to continued labour of your own under these two Ministers of Agriculture, what is best for the various areas in the way of manure, what are the successful pureline seed paddy strains that we must encourage cultivators to use, what are the various problems of pests and diseases that affect the paddy plant, &c. We have taken the right step forward with the guidance of the work that others have produced in the years gone by. We need not plunge in our enthusiasm into mistakes that will be costly both in money and deterrent to the progress of our very objectives. Therefore it is with a feeling of very great responsibility that I place a part of my duty in your hands."

Referring to the experience that a good many of the members had in agricultural pursuits he said that there were men in that room who knew what they were speaking about for the very reason that they had done those jobs in the past. He craved for their indulgence that they would probably speak at meetings and disseminate their knowledge in their various fields. Continuing he said, " But I will also ask from those who have been accustomed to agriculture of a decade ago not to dismiss too lightly what the modern age is bringing to the aid of agriculture. I have a special preference for the mechanization of agriculture. I read not many hours ago of a very great statesman in another land telling a meeting—do not keep on preaching the whole time to the farmers of this land. You are literally trying to teach your grand-mother to suck eggs. I do not think our farmers in this land approach the discoveries and the experiences of the modern age with that spirit of this day. On the other hand the problem of labour is becoming every day a really limiting factor in all that we plan to do in Ceylon and any new developments that claim to reduce such labour is a development that must be carefully examined. Of course, we must as we examine them, keep always in mind the danger of the efficient salesman. The East, especially today, so anxious to increase its production of food, has a very real danger in the efficiency and the plausibility of salesmen of various kinds of machines and aids. There is a country nearby that is seriously considering controlling importation of various kinds of machines because unless we are careful our centres of agricultural development may soon become cemeteries for untried makes of machinery unsuitable for our particular conditions and for our particular requirements. But this does not mean that we must not use fully equipment that has been tried in other lands and tried successfully. But in dealing with all such equipment we must always bear in mind that a tractor, to be a tractor one year after

purchase, requires an addition of probably 20 per cent. of new parts and that these additional requirements of spare parts cannot be avoided during a whole lifetime of such tractor so that when you have a tractor you must have spare parts as well at the same time. A country may sell you tractors and will have no arrangements to provide you either with services or with spare parts. These are obvious dangers that one must guard oneself against. So much so, Sir, for the general approach I think members in this room when they tender advice can tender advice against the background that the hard work of research, that the hard work of experimentation in field and laboratory has achieved.

But that is not all. We are not content as you may have read in the newspapers to rely upon our own efforts. Within a short time the Department of Agriculture and other Food Production Departments will be strengthened by assistance of the best available expert knowledge on the various branches of agriculture ".

Sir Oliver next commented on the spirit of understanding that prevails between the Director of Agriculture himself and the foreign experts who have come here to assist our country. He added—" There has not been one objection to the considerable assistance from outside being made available to us. These men come to us from various world organizations not with any objective to secure any post held by Ceylonese. They come with the prime objective of serving Ceylon. They ask for no status. They only ask for an opportunity to work, and I am pleased to be able to record that there has been no resistance from any permanent member of any of my Departments to the addition of this assistance from abroad, and I want to assure these Experts who come to us that there will be an additional increase in their numbers in the near future when people in this room and those outside this room will fully appreciate their singlemindedness in helping us ".

Referring to the history of this country since its achievement of independence he said, " We at any rate can claim, if nothing else was achieved, that we did maintain law and order in this country for the four or five years of freedom. There is in this land no religious prejudices, no communal prejudices. I cannot think and my memory goes back nearly half a century, of a period in our existence when all the communities of this land have been better joined together than now. But I think a great responsibility lies on the permanent population of this country. Are we making sufficient use of the fact that every single race in this land is prepared to work for the well-being of Ceylon ? I have a feeling that we are still carrying in our minds matters and circumstances that should be forgotten; that we are not asking our friends from outside to help us sufficiently. We have established in the field of agriculture three great divisions of ownership. We have the ownership of limited liability companies, sterling and rupee, we have the ownership of our own individual capitalists and we also have the ownership of the small-holder. This classification of ownership varies in the various items of agriculture. In paddy, as you know there is no ownership of the first group, but there is comparatively small ownership of the local land-owning class and the small men of Ceylon. In tea, it is different. Its ownership is in limited liability companies and there is comparatively little ownership by big land owners and ownership by small-holders.

In Rubber I think the division is that the small-holders probably have half of the acreage and a very bad half, and the remainder is equally divided between company ownership and individual ownership. You are aware of the very far-reaching powers that the Government of this country is about to obtain in regard to paddy land. I shall come to that a few moments later but I only want to make this point clear that these far-reaching powers are being secured in regard to paddy lands for one purpose and one purpose alone, and that is the land should be made to yield its maximum crop for the benefit not of the owner,

but of the country. I submit that all those who own tea in this country, all who own rubber in this country, have a similar responsibility. Ownership of land in the 20th century is no longer a privilege that the individual or the group can exercise according to his personal pleasure. It is his duty to make the land produce the maximum in order to secure the well-being of the country.

Therefore if during my tenure of responsibility as your Minister, you see increasing pressure on land owners of all groups for better cultivation of their land, for the protection of the top soil without which the land is of no use, for better production methods of rubber and tea, you will understand that these steps are being taken in the spirit I have tried to explain—that a landowner is the trustee of that land and that he just cannot neglect its productivity simply because he cannot be bothered about it. Ladies and Gentlemen, it is the responsibility of a landowner to keep his land free of disease and pests. You have probably seen the Regulations that have been framed in order that certain areas of rubber that must be preserved should be free from Oidium. There may be an idea prevalent that the requirements of the law may not be seriously followed. I want to take this opportunity to correct that idea. Literally for those who have to free their plantations from Oidium, there has been a very liberal classification, with the assistance of the two great Associations that look after the plantation industries of this land, of the areas that must be sulphur-dusted. Very great trouble has been taken to make this sulphur dust available. You know the difficulties we had last year. We have overcome those difficulties and now it is the responsibility of those who own rubber land in these areas. Owners of those lands must bear in mind that if they do not discharge their responsibility we will take action that we do not like to take but which one has to take if one should discharge fully his responsibility towards his country.

Similarly, Sir, Ladies and Gentlemen, in many other directions while I am prepared to assist to the fullest degree those who cannot help themselves, I shall expect from the large group who can help themselves a reasonable sacrifice of their earnings. I was talking of rubber. You only have to spend an afternoon driving through some of the rubber areas of Ceylon to realize what a tragic fate is facing this industry in Ceylon. You only have to examine our exports of rubber in the last 36 months to understand how, despite colossal increases in price, the actual production has dropped. There isn't I think a single home in this Island to whom matters like free education, free health services, maintenance of law and order in this land, the right to follow the religion that one wishes to, the right to express one's own views freely and all these things are not very precious. I would like to ask them how and what chances they have of preserving this nation in the years to come if our three major industries of rubber, tea and coconuts steadily reduce their exportable output. And it is literally true that rubber and tea are facing problems that they have never faced before. It would be a bit more helpful if the industry can maintain its production, if the industry can reduce the low grade teas that are apparently a glut in the market at the moment. But in regard to all three items and in regard to the smaller items of our agriculture the call today is for increased production not only in the interests of those industries in the Island, not only in the interests of those who own them, but in the interests of the whole country.

Therefore while I would like this Board to constantly bear in mind the urgency of food production, and that is a real urgency, I would commend to them very sincerely that the increased productivity of all the other items in our agriculture are equally or almost more important.

Now turning to food production, you know the general picture. Ten years ago our food bill of this Island was about Rs. 160 millions. Today for the same items we pay Rs. 700 millions and the bill is reaching proportions that can only be maintained against a background of boom prices for tea, rubber and coconuts. Anybody who plans the future of a country like Ceylon on the certainty of boom prices for our major products cannot be in his proper senses. We have an urgent problem—we must reduce our dependence on other countries. There used to be a saying that any country which depends for its food and for its armaments can never be free. Thank God, Ceylon can waive the requirements of armaments but we can never be truly independent, we can never speak fearlessly in the Councils of the world so long as we are dependent upon other countries and the ships of other countries in order to feed us. Therefore the urgency and the importance of reducing this dependence on other lands cannot be exaggerated. You are probably aware of the various steps that are being taken. I was interested to read the minutes of your last meeting and the views of one of the members of the Board, Mr. C. Wijesinghe, in regard to the necessity of guaranteed prices and better marketing methods for all items of agricultural produce. I think we can claim now that a fair price is being paid for most items of grain in this country and that reasonably good marketing arrangements and purchasing arrangements are now in the way of being implemented. Therefore some of the difficulties that you foresaw in the years gone by do not exist, but there is still a great deal to be done.

I should like to explain here why I thought it necessary that two of our outstanding leaders of the women of this country should be invited to attend our deliberations. There has come into existence in this land of ours within the last few years two or three great movements that must give us a chance better than any other land in Asia—the great Co-operative movement, the Rural Development movement and the Women's movement (Mahila Samithis). These three movements properly utilized can, I submit, be an inducement that will change our life in order that we may harness our resources with the addition of that half of our population that these women societies represent, and I have thought it necessary in our interests to invite Lady Molamure and Miss Cissy Cooray to join us. You have seen references in the press to various efforts that we are making to improve the cultural methods of paddy cultivation—transplanting and weeding, the advantages of the compost pit, the necessity of cultivating home gardens. How little of these can ever be achieved unless we can enroll in this objective the women and children of Ceylon, and I appeal to both of you ladies to assist and discharge this responsibility that probably only you two can discharge. Wherever you go I have seen you in meetings of Rural Development Societies or in meetings of Women's Societies, your leadership is accepted without demur. You serve not to be a M.P. or a Minister but you serve because you believe that your service is of benefit to Ceylon. You can, I submit without exaggeration, get the women and children of Ceylon on the side of Government, on the side of those who have to produce our food, in a very high degree. I think I can claim to speak with experience of how ready this response was during the last War when almost overnight I found voluntary helpers to man two thousand Milk Feeding Centres. The response was universal. I think as a result of our education, as a result of the encouragement that our efforts receive at the hands of teachers, we have an opportunity which has never before been available to Ceylon. I would therefore like to feel that this almost complete range of Women's Societies are ready to shoulder their respective burdens.

You know Ladies and Gentlemen the picture of agricultural planning in this country, You know how much reliance I place on the deliberations of District Agricultural Committees and I especially welcome the representatives of these Committees this morning. I am hoping

that both the district and the centre will benefit by their presence in the Central Board. To the district they must take the picture back or the general plan, and to the district they must take back the responsibilities of the centre. To this Central Board they must in turn bring back the information, without which the work of the whole Department or the whole Board would be worthless, or how effectively these plans are being implemented in the various districts from which they come."

At this stage Sir Oliver referring to a suggestion made by Mr. Spencer Schrader that the minutes of Board Meetings should be abbreviated as they looked more or less like Hansard reports, since some members took a great pleasure in repeating past history, said that it was interesting to listen to people who would say when a suggestion was made at the Board that that very suggestion was made by him 10 years ago in the form of a resolution. He added that it was a matter of interest and furthermore they should not object to the satisfaction which a speaker got by being able to say that at least the present members were being converted when it was not possible some 10 years ago.

Sir Oliver continued—" But Ladies and Gentlemen, I am hoping that this Central Agricultural Board as is now constituted would be primarily the eyes and ears of the Minister for there are members here seeing things in their respective areas. I do not think that my Director would in the slightest degree object to your letting him know exactly, in a meeting like this, during your tenure of office, that things are going wrong in an area or things are going on well in an area or that you want certain things done in an area or how his plans should be amended in order to suit a particular Division or a particular area. I think that should be your prime obligation. These things may only be said at such a gathering whereby a mistake made right through the year, right through the whole period of your work in this Central Committee may be corrected. I am certain that the Director—I certainly would have myself—would welcome a running commentary of criticisms and observations. All of you are experts. You ought to know that if you get a complaint from a public officer that there is always another side to that complaint and probably the same thing applies to every complaint from members of the general public. You can sort these out but do not, I beg of you, be exclusive in your own areas; make them feel that the member of the Central Board of Agriculture is somebody that those in the villages around you can approach, somebody who would give them the leadership that they are always so ready to accept. And if you establish that leadership clearly, as I said, I have a great cause for thankfulness. This room is full of the cream of the leadership of this land. There should be no difficulty for you to make the Central Board of Agriculture a powerful force, the biggest leadership, with great responsibility that awaits us.

Ladies and Gentlemen, I have secured the agreement of your Chairman that for the remainder of the time of this Board you should be free to make comments and to ask questions both from him and myself. I want to submit myself very clearly before you. I do not pretend to know everything about these special problems of Agriculture. I do not claim to have any special aptitude but I only place before you my own capacity to work here if I can get from you the necessary assistance. I submit to this meeting that in the few years ahead of us we have a number of great services. Let us get together the leadership we see in our schools, in our temples and in our churches. Let us take advantage of the leadership that we see in those who are better off than the bulk of the people of this Island. Let us utilize the friendship of the man of many parts and think this is a land of good peoples to live in and to work in. I do not think that at any time in the history of this land there has been a greater number of those urgent needs. We must take the opportunity

at once. If we wait another year or two years that opportunity may not be ours. I sincerely say that the enemies of freedom are not imported from other lands. They arise in our own backyards of poverty, misery and disease. You and I have a great opportunity of service to make a contribution to reduce this misery of our people so that freedom may always prevail in this land ".

At the conclusion of his speech, Sir Oliver said that he was prepared to answer any questions or listen to any observations that members would like to submit.

Mr. K. Morford suggested that is would be very advantageous if the Director of Agriculture could instruct the Agricultural Instructor of the area and others to get in close contact with the member of the Central Board in the district so that the member concerned could be of greater assistance in the matter of food production. He also inquired whether the co-operation of estates could not be enlisted in the matter of food production. He submitted that there was a feeling in his own district that there were insufficient Agricultural Instructors to carry out the work effectively.

Sir Oliver in reply said that he was glad that Mr. Morford had referred to the importance of the members of the Board getting recognition in their respective areas as leaders. He said that he would do his part in the way of instruction to Agricultural and Revenue Officers and that if the member concerned could spare an hour on a Sunday afternoon, he could send for the Agricultural Instructor or the Village Headman or the Food Production Officer or Overseer and discuss matters concerning agriculture and food production. He emphasized the necessity for these officers to stand by the representative of the Central Board in their respective areas and if that could be done, he said, they would be doing a great service. In regard to a point raised by Mr. Morford he said the question was whether there was no way in which he could get the estates of Ceylon to function as if they belonged to Ceylon. He said " they were too much in compartments of their own. The Co-operative movement had only touched the fringe of their problems. I do not think it is in the well-being of a country that nearly one million people out of a total of over seven millions should succeed in living a life apart from the rest of the population. I want to see a beginning from the top and from the bottom. I do not want to say anything at this meeting about leadership of the rank and file but I would like to appeal to those who represent the larger planting interests in this country that there might be a dividend if we can get proprietors and superintendents and assistant superintendents of our plantation areas to take a live and active interest, say in the Rural Development, in the Co-operative movement, and in the various other movements begun in our land. I do not think it is good for you—it is certainly bad for us—to continue much longer in this practice of a superintendent of an estate, be he of any race, feeling that so long as he looks after the labour in his estate and the interests of the proprietors and possibly keep up his own status in his own particular club that he is discharging his full responsibility as a citizen of this land, as an important citizen of this land. If we are to keep the forces that we detest away from our land, we cannot allow the cream of our leadership not to take an interest in the villages that surround their respective provinces ".

Mr. Albert Godamune observed that the Honourable Minister had laid particular stress on the plantation industries of the Island while the question of food production did not receive sufficient emphasis. He stated that paddy production in the Island deserved first priority in any discussion on agriculture and suggested that a special meeting of the Board be summoned to discuss that subject alone and that it should be a full day discussion.

Sir Oliver stated in reply that he did make reference to food production in the course of his speech and probably the member had not heard him. He added that he also referred to the three major export industries. He said he agreed that the most important industry, taking acreage and the numbers involved and the volume of output, was rice. The only point he wanted to make was that after having for nearly a period of a century and a half forgotten the paddy industry they should not for the next half century forget the three other major industries. He said he would agree that just at the moment probably because the three other industries are reasonably looked after by their respective research bodies and strongly covered by two planting associations they would be alright. In conclusion he requested the Chairman to put on the agenda of the next Central Board meeting a few items relating to food production as a subject and if necessary to have a full day discussion and that he should very much like if they could invite him also.

Mr. C. Wijesinghe speaking next said that they had just heard from the Minister that nearly 700 million rupees were spent on imports of essential requirements for this country which meant that the total export value of the tea industry was almost wholly utilized for that one purpose. He said that if reference was made to export figures it would be noticeable that the figures for coconuts had come down by nearly 50 per cent. He said that industries which had reaped very high profits during boom prices and which had saved some money should be given every encouragement to go in for food production. He said that although estates had changed hands since the Colonial days, the national wealth of the country had diminished. He also urged that the Paddy Bill should be implemented as soon as possible if the country was to take a step forward in the direction of paddy production.

Referring to a resolution that was passed at the Central Board in the previous year that paddy should be exempted from taxation, he said that that very resolution had come up before the Board some 10 years ago. He said that all taxes on paddy either in the form of income tax, water tax, " *huwandiram* " or any other form of taxation on paddy should be waived until such time as the country was self-sufficient in paddy or until the country could once again export her rice. He added that ample resources should be made available by Government to all those who would take up to this industry whether they are peasants or middle class land owners or the capitalist class. He said that the capital invested on an industry of this nature was risk capital and if risk capital was to be invested there should be risk profit in it.

He said that as a practical farmer he owned a small unit for his own requirements and he was happy that his yields had gone up by three times in his own village. He emphasized that there was no reason why, if cultivators had security of tenure and if fragmentation was stopped, higher yields in paddy could not be expected. He also emphasized that a guaranteed price for paddy as for other products was also a great encouragement to cultivators.

Replying to the observations of Mr. Wijesinghe, Sir Oliver said that in regard to the Paddy Bill he would like to say that the Bill would soon be law. He said that the implementation of it would give rise to various problems and requested the Central Board members who are particularly interested to devote a little time to the consideration of what would be the most effective regulations and what would be the most effective implementation. He added that people like Mr. Godamune and others who knew all the difficulties

attendant on cultivation would be very helpful. He felt that that was a matter on which their experience would be of great help and requested them to put that down on their priority lists as the first important matter requiring consideration.

On the second point raised by Mr. Wijesinghe, he said that that was not a subject of his Ministry but the Land Utilization Report made it possible for them to secure the assistance of all classes—large owners, small owners, middle class owners, and capitalists—in the food production venture. He had heard an encouraging comment from the Prime Minister that Bulankulame Dissawa and the Chairman, Gal Oya Board, had been asked to consider leasing an extent of about 10,000 acres from the left bank, an extent of land that they would normally not be able to develop for another ten or fifteen years, to capitalist and middle class cultivators.

In regard to Mr. Wijesinghe's suggestion that paddy should be exempt from all forms of taxation, Sir Oliver said that it was not an easy matter though on principle nobody could criticize it. He said that he would not like to give any promise in that matter without a decision from the Finance Minister. That was a matter which had been brought to the notice of the Finance Minister on several occasions. But he had got his agreement to remove certain duties on agricultural implements and that action would be taken on that matter.

Mr. Sivapalan said that he was extremely happy at the presence of the Minister at that meeting and he was thankful to him for the contribution he had made in the day's proceedings. He also assured him that the responsibility he expected from them would always be forthcoming in abundance. As regards food production he said he could remember a time when quantities of literature were scattered in the country and the cultivators were told to increase their yields. He hoped that a more practical way of tackling the problem would be started. He also stressed the necessity of extending the cultivation of food crops for the reasons that the population was increasing at the rate of 200,000 a year. He believed that a more practical way of judging the achievements of the cultivator in food production was to see whether his yields were higher than the previous year. That, he said, should be impressed on the minds of all citizens of this country and they should be encouraged to follow more practical methods and the success of the food production campaign should be assessed on the actual crops that they got. He added that food production did not mean spending large sums of money on clearing large tracts of land. The organizations responsible should be able to prove to the country that the returns were greater than the previous year.

In regard to the statement of the Minister that 10,000 acres of land would be made available in the Gal Oya area, Mr. Sivapalan said that he would like to bring to the notice of members that thousands of acres of land were lying idle in the Trincomalee District which could easily be cultivated by middle class Ceylonese. He emphasized that there was plenty of land in the dry zone which could easily be made use of for food production and that there were thousands of middle class Ceylonese who were willing to cultivate this land if it was made available. In conclusion he requested the Director of Agriculture to summon a special meeting of the Board to discuss the question of making available for food production the necessary land.

Sir Oliver repyling to the observations of Mr. Sivapalan said " The report of the Land Utilization Committee should be before the public in a matter of weeks, say probably in a month or two. Then decisions on matters that Mr. Sivapalan has spoken about should be known. I only want to say this : we have had one experience during the last war of

cutting down forests and of growing food under emergency conditions. It was done by a very rich fellow, the Government of this country, and many of you are aware of the disastrous situation this created. I can agree with Mr. Sivapalan that land is mostly available in the dry zone, for there are about three million acres of land that should be brought under cultivation. But what are the problems facing this ? It means repairing probably 20,000 small tanks in this 3 million-acre area. We are now repairing these tanks at the rate of 300 a year. I agree with Mr. Sivapalan that a complete solution to the problem can only come from the dry zone where land is available. It cannot come from the wet zone where probably all the possible land is already under cultivation. We are, with the assistance of experts, reaching a stage when we could do not only dry zone cultivation but also see the development of the livestock industry. But there are dangers in opening up these forests without a planned method of soil conservation. You will get your rice for one year or you will get it for two years, but at the end of it all you will be left with a land that will be useless for 50 years. We have got to guard against that ". In conclusion he said that the report of the Land Utilization Committee would be considered carefully and that steps were already under way in the other Ministry for the prevention of fragmentation. He hoped that action would soon be taken probably in the next half year, and requested the speaker to be a little patient and to help them in that Committee.

In answer to a question by Sir James P. Obeysekera, the Chairman said that trials with the pre-treatment of paddy have been carried out in the Eastern Province by Research Officers of the Department and that the treatment referred to has been beneficial with certain varieties. The trials, he said, were still in the experimental stage, and he would not like it to be considered as an established fact for all conditions of paddy cultivation. He said that if the experiment produced any conclusive results, it would demonstrate a very simple and effective method of increasing crop yield. In conclusion he said that the results of that experiment would soon be published in " The Tropical Agriculturist ".

Mr. A Perumynar next pointed out certain difficulties which the people of the dry zone were faced with. He said that nearly 25 per cent. of the crop was lost to the cultivator by way of cattle and stressed the necessity for Government to adopt some stringent measures in that connection. He also deplored the attitude of Government in saying that the owner of the land has to be responsible for the control of pests and diseases in his cultivation. He inquired why the Government should take that view only in regard to agriculture when it had made provision for the control of all other forms of epidemics in case of an outbreak.

Referring to the problem of landlessness in Ceylon he said that that was one factor which primarily affected agricultural families. He pointed out, from a table of figures, that in the rural sector of Ceylon 26.3 per cent. of agricultural families had no land, 42.3 per cent. had less than half an acre, and 54.1 had less than one acre of land. The position in the Western, North-Western, Southern, and Sabaragamuwa Provinces were similar, except for Hambantota District. The Eastern Province showed a striking difference. The holdings were very large compared to the other parts of the Island, but the ownership of those holdings was confined to a comparatively few, leaving the majority landless. In the Batticaloa District 57.8 per cent. of the agricultural families had no land whatsoever and 62.9 per cent. of all families had no land. In Anuradhapura all villages surveyed were " Purana " villages.

In conclusion he said that the material reviewed clearly showed the meagre extent of land possessed by the majority of the agricultural population and also the high percentage of the agricultural population which possessed no land whatsoever.

Sir Oliver in reply to Mr. Perumynar said that as regards the control of pests and diseases in agriculture, Government had already taken steps with the responsible officers for the control of such diseases. He would also issue instructions that all Agricultural Instructors should be given a training in the identification of pests and diseases and the use of simple equipment for their control and eradication. In regard to landlessness in the Island, he said that Government was quite alive to the problem. They had implemented several colonization schemes and several others were under way.

Major E. C. de Fonseka at this stage inquired what the present position of the proposed Milk Board was.

Sir Oliver in reply said that the Milk Board was being established and that its functioning would soon be statute law in this country. He hoped that the Milk Board would fulfil all the great expectations that everybody had been talking about and thinking about. In that connection he said he would appeal to all owners of coconut land to establish a second crop in their land, and that was a crop of livestock. He said that everybody would be aware of the difficulties inherent in a country like Ceylon for establishing livestock but he was prepared to give sufficient help to any organized scheme. He was prepared to help in the disposal of the livestock not necessarily through Governmental organizations but through others who deal in livestock. He was certainly prepared to help as a Government activity the marketing of milk, and he was prepared to guarantee marketing arrangements to all those who were prepared to risk their capital in increasing livestock in Ceylon.

At the conclusion of the proceedings the Chairman reminded all members and others who were present in that room that the Honourable the Minister has invited all of them for lunch and that there would be an agricultural film show after the lunch. After the film show, he said, those who would like to participate in the proceedings of the School of Agriculture, Speech Day were cordially invited to do so.

The meeting terminated at 1 p.m.

M. SIVANATHAN,
Secretary,
Central Board of Agriculture.

Peradeniya, December 10, 1952.

Rubber Research Institute of Ceylon

MINUTES OF THE 117TH MEETING OF THE RUBBER RESEARCH BOARD, HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON MONDAY, JANUARY 26, 1953

Present.—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. G. H. Dulling, Mr. R. J. Hartley, Mr. W. Herbert de Silva, and Dr. H. E. Young (Director, R. R. I. C.).

Dr. A. W. R. Joachim, Mr. R. H. Wickremasinghe, and Major Montague Jayewickrema, M.P., had intimated their inability to attend the meeting. Major Jayewickrema was granted leave of absence from the meeting as requested by him.

1 Minutes

(*a*) Confirmation.—Draft minutes of the meeting held on October 27 and the special meeting on December 23, 1952, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) Matters arising from the Minutes:

1. *Medical Board.*—It was noted that arrangements had been made for the services of Government Medical Boards to be made available to the Institute.

2. *Senior Staff Medical Scheme.*—Proposed rules for the Senior Staff Medical Scheme were approved subject to a few minor amendments.

2. Reports and Accounts

(*a*) Statement of Receipts and Payments for the 3rd Quarter 1952 was tabled.

(*b*) Director's Report on Visit to U.K. was approved.

3. Experimental Committee

Recommendations made at meeting held on January 12, 1953.

(*a*) Visiting Agent's Report.—As recommended by the Committee it was agreed that the V. A's Report be accepted with the exception that it was not considered that the purchase of a bulldozer was desirable.

(*b*) Tenders for Buildings.—The Committee's recommendation that tenders for as many buildings as practicable in the 1953 programme be called for in a single tender was accepted.

4. Smallholdings Committee

Recommendations made at meeting held on January 12, 1953.

(*a*) Transfer of S. H. Department to Nivitigalakele.—As recommended by the Committee it was agreed that the transfer of the S. H. Department to Nivitigalakele was not practicable because of the implications of co-operation with the Rubber Commissioner and also because of the lack of accommodation for staff at Nivitigalakele.

5. Staff

(*a*) Contract Period of Senior Staff.—Agreed that the contracts of Senior Officers should cover the period of service as well as the end-of-contract leave in each case.

(*b*) Scholarship for Research Assistant.—It was reported that Mr. A. J. Jeevaratnam, Research Assistant (Agronomy Department), had been awarded a scholarship by the Australian Government under the Plan for Technical Aid to S. E. Asia, and had left Ceylon on January 21, 1953.

(*c*) Intermediate Staff.—The following appointments were reported:—

1. Mr. L. Wijeyegunawardena as Plant Breeder (Botanical Department) with effect from January 2, 1953.
2. Mr. M. Nadarajah, B.Sc. (Ceylon), as Research Assistant (Chemical Department), with effect from December 15, 1952.

(*d*) Assistant Staff.—Changes in staff since the last meeting were reported.

6. London Advisory Committee

Minutes of the 57th meeting of the Committee and 4th meeting of the Executive Committee were tabled.

The meeting terminated at 3.40 p.m. with a vote of thanks to the Chair, proposed by Mr. Hartley.

MINUTES OF THE 118TH MEETING OF THE RUBBER RESEARCH BOARD, HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON MONDAY, FEBRUARY 23, 1953

Present.—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. W. Herbert de Silva, Mr. R. J. Hartley, Mr. G. H. Dulling, Major Montague Jayewickrema, M.P., Gate Muhandiram Arthur D. S. Jayasinghe, Dr. A. W. R. Joachim, O.B.E. (Director of Agriculture), Senator C. F. W. Wickremesinghe, Mr. R. H. Wickremesinghe (Controller of Supply and Cadre), and Dr. H. E. Young (Director, R. R. I. C.).

Mr. E. W. Whitelaw attended by invitation.

After the minutes of the last meeting were confirmed, the Chairman welcomed Mr. E. W. Whitelaw who had been specially invited to attend the meeting. Mr. Whitelaw was for a number of years one of the best known planting personalities in the rubber industry in Ceylon, and his views regarding the present state of the plantation rubber industry in Ceylon were welcomed by the Board. Mr. Whitelaw was also a member of the Commission on the Rubber Industry in Ceylon, whose valuable report was submitted in 1947.

Mr. Whitelaw thanked the Chairman for having invited him to attend the meeting. He was no stranger to the Board as he had served on it for 14 years before he left Ceylon. He thought the greatest danger to Ceylon's rubber industry was the spread of oidium leaf disease, and he was very happy to note from a recent article in the press that a satisfactory solution to the problem had been found in the clone LCB. 870 which has been proved to be resistant to this disease. He considered that this was of very great significance to the rubber industry and was in fact the most important occurrence for Ceylon rubber for many years. As the clone was now known to be a moderately high yielder, he endorsed the Board's opinion that it was the best material for use by smallholders. The crown budding technique adopted in Ceylon for budding high yielding trees with resistant material was also being used in other countries for resistance to other diseases.

The meeting terminated after the consideration of a few domestic matters.

Tea Research Institute of Ceylon

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD AT 2.30 P.M. ON FRIDAY, NOVEMBER 21, 1952, AT THE PLANTERS' ASSOCIATION OF CEYLON, 113, STEUART PLACE, COLPETTY, COLOMBO

Present.—Mr. R. C. Scott, C.B.E., (Chairman), Dr. A. W. R. Joachim, M.B.E. (Director of Agriculture), Mr. W. H. Gourlay (Chairman, Planters' Association, Agency Section), Mr. W. R. Vander Kiste (Chairman, Planters' Association of Ceylon), Messrs. H. S. Hurst, A. J. Dickson, D. E. Hettiarachchi, Errol Jayawickreme, A. D. McLeod, G. K. Newton and J. Lamb (Director and Secretary).

1. **Notice convening the meeting was read.**

The Chairman announced that Messrs. V. G. W. Ratnayake, M.P., G. J. Harris, and W. Neal de Alwis, M.P., had intimated their inability to be present at the meeting.

2. **The minutes of the meeting of the Board held on July 18, 1952, were confirmed without comment.**

3. **Membership of the Board and Committees**

(*a*) Board.

The Chairman reported that—

(i) He had returned from long leave and resumed the Chairmanship of the Board as from November 20, 1952. Mr. R. J. S. Bean, who had been nominated in his place, had therefore been relieved from the above date. He expressed his thanks to Mr. H. S. Hurst for acting as Chairman of the Board during his absence.

(ii) Mr. A. D. McLeod had also resumed his seat on the Board on his return from leave as from October 23, 1952. He had relieved Mr. L. F. J. Smith who had acted for him.

He welcomed Mr. McLeod back to the Board and thanked Messrs. R. J. S. Bean and L. F. J. Smith for their services as acting members of the Board.

(*b*) Finance Sub-Committee.

The Chairman reported that a seat was vacant on the above Committee as a result of Mr. W. H. Attfield's resignation. He proposed the name of Mr. A. D. McLeod and stated that the Committee had recommended the nomination on account of Mr. McLeod's specialized knowledge of accountancy. Agreed.

4. **Finance**

(*a*) Audited Accounts of the Institute for 1951 and the Auditors' Report.

The Chairman said that copies of the accounts and report had been issued to members under cover of Circular No. A. 15/52 of November 8, 1952.

He stated that the Finance Sub-Committee had that morning considered the Auditors' Report and audited accounts very thoroughly.

Mr. A. D. McLeod proposed and Mr. G. K. Newton seconded the acceptance of the audited accounts of the Institute for 1951 and the Auditors' Report thereon.

(*b*) Institute's Accounts for period ending September 30, 1951.

(1) The Chairman reported that copies of the above accounts had been circulated to members.

The Director stated that the cess was coming in satisfactorily and that to the end of October it had exceeded the figure for last year. There was, however, a big drop in the receipts for the month of October.

In reply to a question from Mr. A. D. McLeod, the Director said that the Norris Memorial Hall was completed but that the formal opening had been postponed.

5. **Staff**

The Chairman reported that—

(*a*) Agricultural Chemist.

Dr. Haworth, who had joined the Institute's staff on August 1, 1950, and had resigned his appointment as reported at the last meeting, left Ceylon on November 6, 1952.

Applications from ten candidates had been received for the post of Agricultural Chemist. The appointments Sub-Committee had on the Director's recommendation approved that Mr. D. H. Parish, B.Sc. Hons., Leeds University, at present Assistant Lecturer in Agriculture, Queen's University, Belfast, and Mr. J. A. H. Tolhurst, B.Sc. Agric. with Hons. in Agricultural Chemistry, Reading University, age 30 years, presently employed as Scientific Officer at Long Ashton Research Station, be short-listed. The Committee had also approved that Dr. F. R. Tubbs should interview these two gentlemen.

(*b*) Mycologist—Mr. B. N. Webster.

The Chairman reported that Mr. Webster's agreement was signed at St. Coombs on October 18, 1952. Messrs. H. S. Hurst and G. K. Newton had signed on behalf of the Board.

(*c*) Engineer—Mr. J. Landreth.

The Chairman said that members of the Board had already unanimously approved the Director's recommendation set out in Circular No. A. 12/52 of September 23, 1952, that Mr. Landreth should proceed on leave in order to have a holiday which he badly needed and also to be able to take his wife to the United Kingdom for urgent medical attention.

The Chairman said that the Board had also agreed to the appointment of Mr. B. D. Garnier to act for Mr. Landreth during his absence.

(*d*) Superintendent, St. Coombs Estate—Mr. F. C. Daniel.

The Chairman informed members that information had been received that the Ceylon Association in London had approved in principle the proposals regarding the appointment of a Superintendent for St. Coombs when Mr. Daniel retired.

6. **Minutes of the 81st Meeting of the Estate and Experimental Sub-Committee**

The Chairman said that copies of these minutes had been issued to members under cover of Circular No. A. 17/52 of November 17, 1952.

Members would have noted that the Visiting Agent's report dated August 6, 1952, copies of which were issued to members under cover of Circular A. 10/52 dated August 19, 1952, was discussed by the Committee at the meeting.

The Committee had also recommended the approval of the following additional votes on 1952 account:—

(i) Rs. 8,000 for maintenance of cart road.
(ii) Rs. 5,000 for re-roofing lines.

Approved.

Members would have also noted that the Committee had recommended the inclusion of several items in next year's estimates. These would accordingly be incorporated in the estimates which would come up for consideration at the next Board meeting.

The Committee also recommended that the next Conference be held at the Regal Theatre, Nuwara Eliya, on Friday, March 6, 1953. The theme suggested for the Conference was " General Agricultural Problems ". Agreed.

7. Small Holdings Advisory Service

The Chairman reported that the minutes of the meeting of the Small Holdings Sub-Committee which was held on September 1, 1952, had been issued to members under cover of Circular No. A. 14/52 of October 4, 1952.

The Director said that a full discussion on Small Holdings had taken place and he had prepared a report on the subject of aid to small holders. Government had since taken the matter up and further developments are awaited.

8. Electric Supply

The Chairman reported that, as decided at the last Board meeting, work in connection with the linking up of St. Coombs to the Government electric supply had been put in hand and it was likely that the scheme would come into operation within a month's time.

It is now proposed to complete the whole scheme at one time instead of in stages as originally proposed. The complete work is estimated to cost approximately Rs. 93,000.

One of the three Tangye engines was sold for Rs. 7,600. He said that the Finance Sub-Committee had, after considering the matter, agreed to recommend the approval of the Director's proposal to have the whole scheme completed at one time. He informed members that the agreement between the Government and the Institute was to be signed at the Chief Engineer's Office, on Saturday, November 22, 1952. Messrs. G. K. Newton and A. D. McLeod had agreed to sign on behalf of the Board.

Mr. H. S. Hurst proposed and Mr. Errol Jayawickreme seconded a proposal that the Board agree to the signing of the agreement and the use of the Board's seal thereon. Unanimously approved.

9. Any Other Business

(*a*) Passara Sub-Station.

The Chairman reported that Mr. G. D. Austin, Assistant Pathologist, had returned to Passara at the beginning of November after an absence of six months at Hapugastenne, Ratnapura, where he had carried out experiments on shot-hole borer and Rhizoctonia. These experiments were carried out on both Hapugastenne and Galbodde estates with the co-operation of Messrs. James Finlay & Company.

(*b*) St. Coombs Co-operative Stores.

The Chairman reported that the building in which this store was housed was completely gutted by fire on the morning of July 28, 1952. All goods together with those books of the society which were stored in the building were destroyed. The fire is believed to have been due to a short circuit in the electric wiring.

He asked for the Board's approval to have the building replaced. Approved.

(*c*) Annual Report of the Board for 1951.

The Chairman reported that the draft of the annual report of the Board for 1951 had been approved by all members.

(*d*) Visit by the Minister of Agriculture and Food.

The Chairman reported that, as notified to members by Circular No. A. 13/52 of September 23, the proposed visit to the Institute by the Minister of Agriculture and Food, Sir Oliver Goonetilleke, did not take place.

The meeting terminated with a vote of thanks to the Chair.

MINUTES OF MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION, 133, STEUART PLACE, COLOMBO, ON FRIDAY, DECEMBER 19, 1952, AT 2.30 P.M.

Present.—Mr. R. C. Scott, C.B.E. (Chairman), Dr. A. W. R. Joachim, M.B.E. (Director of Agriculture), Mr. W. H. Gourlay (Chairman, Agency Section, Planters' Association of Ceylon), Mr. W. R. Vander Kiste (Chairman, Planters' Association of Ceylon), Messrs. G. K. Newton, W. Neal de Alwis, M. P., J. P., U. M., Errol Jayawickreme, J. P., U. M., G. J. Harris, D. E. Hettiarachchi, J. P., U. M., A. D. McLeod, and J. Lamb (Director and Secretary).

1. **Notice convening the meeting was read.**

Letters regretting inability to attend were received from Messrs. A. J. Dickson, H. S. Hurst, and A. G. Ranasinha, C.M.G., C.B.E. (Secretary to the Treasury).

2. **The minutes of the meeting of the Board held on November 21, 1952, were confirmed.**

3. **Minutes of the Meeting of the Estate and Experimental Sub-Committee held on December 6, 1952**

Copies of these minutes were issued to members under cover of Circular No. A. 18/52 of December 13, 1952. The chief business of the meeting was the consideration of the St. Coombs Estate Estimates for 1953.

4. **Visiting Agent's Report dated December 9, 1952**

Commenting on the very comprehensive report on a visit paid to St. Coombs Estate by the Visiting Agent (Mr. G. K. Newton), the Chairman said that reference had been made to several items included in the estimates for 1953.

5. Finance

ESTIMATES FOR 1953.

(i) *Revised Forecast of Receipts and Expenditure for 1952.*

It was noted that the revised forecast did not show any appreciable difference from that presented to the Board last December.

(ii) *Forecast of Receipts and Expenditure for 1953.*

The Chairman pointed out that for estimating purposes receipts from cess was set at Rs. 750,000, a figure based on the collections for the last two years. Profit from St. Coombs Estate was once more estimated at Rs. 40,000, and with Miscellaneous Receipts at Rs. 7,500 total receipts for 1953 were estimated at Rs. 797,500.

Against the above income, revenue expenditure for 1953 is estimated at Rs. 777,320 leaving a surplus of Rs. 20,180. Capital expenditure however totalled Rs. 280,650. The final position therefore would be a deficit of Rs. 260,470. This figure would, however, on the recommendations of the Finance Sub-Committee, be reduced by Rs. 42,000.

(iii) *St. Coombs Estate Estimates for 1593.*

The Chairman reported that the estimates had been scrutinized first by the Estate and Experimental Sub-Committee on December 6 and then by the Finance Sub-Committee that morning. He would therefore proceed to the consideration of the estimates forthwith.

Revenue Account.—The Chairman informed members that the Finance Sub-Committee had agreed to accept, subject to further consideration by the Estate and Experimental Sub-Committee, the figure of 260,000 lb. as the total amount of crop from St. Coombs.

The St. Coombs Estate estimates for 1953 then approved on the proposal of Mr. W. Neal de Alwis seconded by Mr. Errol Jayawickreme.

(iv) *Research Estimates for 1953.*

The Research estimates were approved on the proposal of Dr. A. W. R. Joachim, seconded by Mr. A. D. McLeod.

6. Staff.

(i) PATHOLOGIST—MR. C. A. LOOS.

It was reported that Mr. C. A. Loos had returned to Ceylon on November 30, 1952, after having completed his scholarship at Rothamsted. He had since resumed duties at St. Coombs.

The Director said that he had received a very favourable report from Dr. T. Goodey, which he would circulate to members.

(ii) AGRICULTURAL CHEMIST—MR. J. A. H. TOLHURST.

The Director reported that Mr. Tolhurst had accepted the appointment of Agricultural Chemist. There was a possibility of his being released in February for a month's course at Harwell, after which he would return to Long Ashton to complete the agreed period for his notice of resignation Mr. Tolhurst hoped to sail for Ceylon in April.

7. Small Holdings Advisory Service

Copies of the Minutes of the meeting of the Small Holdings Sub-Committee held on November 20, 1952, had been issued to members. Attached to the minutes were the estimates for 1953 which had been approved by the Committee.

8. Any Other Business

(i) PUBLICATIONS.

The Director reported several hundred copies of both the Monographs on Tea Production Nos. 1 and 2 remain unsold. He explained that on account of the heavy costs of printing these it was decided to sell them at Rs. 2,50 and Rs. 3 respectively, but the response had been very poor. It was, however, estimated that the costs incurred had been about recovered.

Mr. W. H. Gourlay agreed as a preliminary step to circularize Agency houses with a view to helping in disposing of these valuable publications. The Director could then take what action he thought best. Agreed.

(ii) VISIT OF MR. S. J. WRIGHT.

The Director informed members that as a result of a visit paid about a year ago by Mr. S. J. Wright, formerly Director of the National Institute of Technical Engineering, an application had been made under the Colombo Plan for technical advice on the mechanization of tea cultivation.

The application had been entertained and information received that Mr. Wright was due to arrive in Ceylon at the beginning of February, 1953. His stay at the Institute would last six weeks, and St. Coombs would be his headquarters. The Institute has been asked to meet his subsistence and travelling expenses.

He asked for the Board's approval for a vote of Rs. 1,200 to cover Mr. Wright's subsistence allowance and Rs. 750 for his travelling expenses. Approved.

(iii) CONFERENCE.

The Chairman drew the attention of the members to the fact that it had been decided at the last Board Meeting to hold the next T. R. I. Conference at the Regal Theatre, Nuwara Eliya, on Friday, March 6, 1953.

The Director said that it was intended to make an attempt to clarify the more confusing points of policy in regard to agricultural problems by opening up general discussions on such points.

It was agreed that such items as manuring, shade, weeds, &c., should be raised.

Mr. W. H. Gourlay suggested that arrangements for the Conference should be left in the hands of the Director. Agreed.

The Chairman, paying a tribute to the Director, said that Mr. Lamb was maintaining the prestige of the Tea Research Institute by the tremendous amount of work he had carried out so efficiently.

He then wished all members a Happy Christmas and a Bright New Year.

The meeting ended at 4 p.m. with a vote of thanks to the Chair.

RETURNS

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON—MONTH ENDED NOVEMBER 30, 1952

Province	Disease	Fresh cases during the month	Total number from the beginning of this calendar year to November 30, 1952				Balance ill at end of month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	19	170	—	—	153	17
	Rabies	15	54	4	50	—	—
Colombo Municipality	Foot-and-mouth	4	204	—	—	200	4
	Rabies	4	49	49	—	—	—
Quarantine Station	Anthrax	—	76	76	—	—	—
	Pleuro-Pneumonia	32	326	326	—	—	—
Northern Province	Foot-and-mouth	100	1,572	2	—	1,505	65
	Anthrax	56	164	164	—	—	—
	Rabies	—	3	—	3	—	—
	Black quarter	—	288	288	—	—	—
North-Central Province ..	Foot-and-mouth	—	1,015	22	—	993	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Anthrax	—	16	16	—	—	—
	Rabies	—	3	—	3	—	—
	Black quarter	11	150	150	—	—	—
Central Province	Mange (cattle)	—	259	16	—	241	2
	Foot-and-mouth	—	471	1	1	469	—
	Rabies	4	14	—	14	—	—
	Piroplasmosis	—	2	—	—	2	—
Province of Sabaragamuwa	Foot-and-mouth	—	430	22	—	408	—
	Rabies	3	11	—	11	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva ..	Rabies	1	6	2	4	—	—
Eastern Province	Foot-and-mouth	—	786	35	—	753	—
	Black quarter	—	46	45	—	1	—
Southern Province ..	Rabies	—	5	—	5	—	—

Department of Agriculture,
Peradeniya, Ceylon,
January 12, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON—MONTH ENDED DECEMBER 31, 1952

Province	Disease	Fresh cases during the month	Total number from the beginning of this calendar year to December 31, 1952				Balance ill at end of month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	12	182	—	—	170	12
	Rabies	20	74	4	70	—	—
Colombo Municipality	Foot-and-mouth	—	204	—	—	204	—
	Rabies	3	52	52	—	—	—
Quarantine Station	Anthrax	10	86	86	—	—	—
	Pleuro-Pneumonia	14	340	340	—	—	—
Northern Province	Foot-and-mouth	115	1,687	2	—	1,637	48
	Anthrax	38	202	202	—	—	—
	Rabies	1	4	—	4	—	—
	Black quarter	—	288	288	—	—	—
North-Central Province	Foot-and-mouth	—	1,015	22	—	993	—
	Rabies	1	1	—	1	—	—
North-Western Province	Foot-and-mouth	—	620	19	—	601	—
	Anthrax	—	16	16	—	—	—
	Rabies	—	3	—	3	—	—
	Black quarter	—	150	150	—	—	—
Central Province	Mange (cattle)	—	259	16	—	243	—
	Foot-and-mouth	—	471	1	1	469	—
	Rabies	1	15	—	15	—	—
	Piroplasmosis	—	2	—	—	2	—
Province of Sabaragamuwa	Foot-and-mouth	—	430	22	—	408	—
	Rabies	—	11	—	11	—	—
	Anaplasmosis	—	3	1	—	2	—
Province of Uva	Rabies	—	6	2	4	—	—
	Black quarter	30	30	30	—	—	—
Eastern Province	Foot-and-mouth	—	786	33	—	753	—
	Black quarter	—	46	45	—	1	—
Southern Province	Rabies	—	5	—	5	—	—

Department of Agriculture,
Peradeniya, Ceylon,
January 28, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

4—J. N. B 26185 (4/53)

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON—MONTH ENDED JANUARY 31, 1953

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to January 31, 1953				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	2	2	—	—	—	2
	Rabies	15	15	—	15	—	—
Colombo Municipality	Rabies	6	6	—	6	—	—
Quarantine Station	Pleuro-Pneumonia	32	32	32	—	—	—
Northern Province	Foot-and-mouth	180	180	—	—	121	59
North-Central Province	—	—	—	—	—	—	—
North-Western Province	—	—	—	—	—	—	—
Central Province	Rabies	7	7	—	7	—	—
Province of Sabaragamuwa	—	—	—	—	—	—	—
Province of Uva	Piroplasmosis	1	1	—	—	1	—
Eastern Province	—	—	—	—	—	—	—
Southern Province	Rabies	1	1	—	1	—	—

Department of Agriculture,
Peradeniya, Ceylon,
March 5, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON—MONTH ENDED FEBRUARY 28, 1953

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to February 28, 1953				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	2	1	—	—	1
	Rabies	15	30	—	30	—	—
Colombo Municipality	Rabies	5	11	—	11	—	—
Quarantine Station	Pleuro-Pneumonia	4	36	36	—	—	—
Northern Province	Foot-and-mouth	65	245	—	—	200	45
North-Central Province	—	—	—	—	—	—	—
North-Western Province	—	—	—	—	—	—	—
Central Province	Rabies	4	11	—	11	—	—
Province of Sabaragamuwa	—	—	—	—	—	—	—
Province of Uva	Rabies	1	—	—	1	—	—
	Piroplasmosis	1	2	—	—	2	—
Eastern Province	—	—	—	—	—	—	—
Southern Province	Rabies	1	2	—	2	—	—

Department of Agriculture,
Peradeniya, Ceylon,
March 24, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT—DECEMBER, 1952

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	85·2	+2·1	69·2	—1·0	78	95	4·3	4·46	16	— 3·06
Badulla	76·9	+0·3	64·4	—0·1	80	94	5·1	7·15	18	— 4·08
Batticaloa	82·9	+1·0	73·7	+0·1	83	95	4·4	8·77	24	— 8·22
Colombo	86·0	+0·5	73·1	+0·8	74	93	4·2	6·57	11	+ 0·96
Diyatalawa	73·5	+1·5	58·4	—0·2	82	97	5·6	5·86	19	— 2·21
Galle	83·4	—0·2	73·7	+0·4	79	93	4·8	6·34	17	— 1·48
Hambantota	85·9	+1·4	73·1	+0·1	76	90	2·8	0·77	7	— 4·84
Jaffna	83·9	+1·4	73·5	+0·5	74	90	4·2	3·87	14	— 6·52
Kandy	83·7	+0·7	67·4	+0·1	72	92	4·2	2·63	13	— 5·81
Kankesanturai	83·2	—	75·1	—	76	84	4·9	3·59	15	—
Kurunegala	87·0	+1·2	71·0	+0·3	68	90	3·6	3·61	12	— 3·07
Mannar	84·6	+1·9	75·4	+0·6	78	88	4·0	2·48	12	— 5·22
Nuwara Eliya	69·8	+2·2	48·1	—0·8	78	90	4·7	3·76	17	— 4·57
Puttalam	85·6	+0·9	71·3	+0·1	77	93	3·8	9·55	17	+ 4·11
Ratmalana	86·4	—	72·2	—	71	90	4·0	2·40	11	— 4·03
Ratnapura	89·3	+1·4	71·4	—0·3	72	95	5·4	6·40	15	— 2·51
Talawakele	75·0	+1·5	55·5	—0·6	77	88	3·6	3·67	15	— 1·51
Trincomalee	81·9	+0·8	76·1	+1·4	78	82	5·0	4·89	18	— 8·11

WEATHER SUMMARY—DECEMBER, 1952

IN December again the rainfall was appreciably below normal, practically throughout the Island. The greater deficits, of the order of 5 to 10 inches, occurred in the northern and north-eastern parts, the greatest deficits being 11.60 inches at Rugam Tank, 11.43 inches at Kebitigollewa, and 11.32 inches at Kobonella Estate. Slight excesses were found locally in the neighbourhood of Puttalam, Matugama, and Ruwanwella, the only appreciable excesses being 7.09 inches at Sunderland Estate, Ehelivagoda, 5.33 inches at Sirikandura Estate, Matugama, and 4.59 inches at Nachchikkalli Saltern.

As is usual for this time of year, the heaviest rain was experienced on the north-eastern slopes of the hills, where a number of stations recorded totals above 15 inches. The receipts at St. Martin's Group were more than double this amount, 32.98 inches being recorded at the Hendon Division, and 30.20 and 29.60 inches respectively at the Lower and the Upper Divisions. The only other station that received over 25 inches was Forest Hill Estate, Gammaduwa (27.97). In the north-eastern low-country, in the south-west and in the neighbourhood of Puttalam, the monthly totals ranged from 5 to 10 inches, while least rain was experienced in the south-eastern low-country, where the monthly totals were below 2 inches.

During a greater part of the month the weather was of the inter-monsoon type, with afternoon or evening thundershowers occasionally. They were fairly widespread, and moderately heavy in places, on the 9th and the 11th. North-east monsoon conditions became evident from about the 24th, with monsoon rain in the north and the east and evening thundershowers elsewhere. These rains were fairly heavy and widespread on the 27th.

There were only 3 daily falls over 5 inches, the highest being 6.05 inches at Puttalam (Western Saltern) on the 9th.

Day temperatures were considerably above normal, while night temperatures did not deviate much from average. The highest temperature recorded during the day was 92.7°F. at Ratnapura on the 23rd, while the lowest temperature for a low-country station was 60.1°F. at Anuradhapura on the 18th, and the lowest for the whole Island, 35.9°F. at Nuwara Eliya on the 21st. The mean humidity ranged from 70 to 80 per cent. by day and from 85 to 95 per cent. by night. Cloud amounts and wind strength were below average. The wind direction was variable at the beginning, but mainly north-easterly during the latter half of the month.

Rainfall—October, 1952, to January, 1953

		Total inches	Average inches			Total inches	Average inches
1.	Point Pedro ..	21·57	41·29	7.	Galawela ..	16·70	41·21
2.	Mannar ..	11·34	28·40	8.	Nalanda ..	32·30	49·90
3.	Mullaithivu ..	23·49	46·59	9.	Gammaduwa ..	52·40	72·21
4.	Anuradhapura ..	19·33	33·71	10.	Rangala (St. Martin's Upper)	85·90	116·77
5.	Minneriya ..	20·97	50·26	11.	Badulla ..	26·27	40·69
6.	Topawewa (Polonnaruwa)	32·55	46·50	12.	Haputale ..	24·64	45·74

D. T. E. DASSANAYAKE,
Director.

METEOROLOGICAL REPORT—JANUARY, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Anuradhapura ..	84·5	+1·3	67·8	—1·4	76	97	5·0	2·88	15	— 2·92
Badulla ..	75·5	—0·7	63·9	+0·2	83	94	6·9	10·10	20	— 0·22
Batticaloa ..	81·5	0	72·8	—0·8	86	95	5·6	16·73	17	+ 3·85
Colombo ..	86·7	+0·2	71·8	0	70	90	5·5	3·79	9	— 0·17
Diyatalawa ..	70·7	—1·1	57·9	+0·3	83	94	7·2	6·06	16	— 0·58
Galle ..	83·2	—0·6	73·5	+0·6	78	93	5·8	3·47	11	— 0·41
Hambantota ..	85·5	+0·6	72·8	+0·2	75	88	5·5	5·62	12	+ 1·62
Jaffna ..	84·0	+1·0	72·4	+0·3	71	90	5·2	2·62	11	— 1·79
Kandy ..	83·8	+0·3	66·8	—0·2	69	89	5·0	2·11	10	— 4·23
Kankesanturai ..	83·3	—	75·0	—	73	82	5·6	2·24	9	—
Kurunegala ..	87·1	+0·7	69·4	—0·4	63	90	5·2	0·86	7	— 4·25
Mannar ..	84·5	+1·3	74·5	+0·3	75	90	5·4	1·43	4	— 2·41
Nuwara Eliya ..	68·1	+0·4	47·8	+1·0	78	90	6·0	5·06	12	— 1·90
Puttalam ..	85·8	+0·4	70·5	+0·5	72	93	5·0	4·12	11	+ 0·69
Ratmalana ..	87·2	—	71·1	—	70	95	5·1	4·75	9	+ 0·60
Ratnapura ..	89·8	+0·5	71·4	+0·3	72	95	6·4	4·46	14	— 1·80
Talawakele ..	73·8	—0·4	55·2	—0·2	72	85	4·7	3·45	9	— 0·42
Trincomalee ..	80·6	+0·1	75·3	+0·1	79	82	6·0	11·12	16	+ 2·81

WEATHER SUMMARY—JANUARY, 1953

THE main feature of the weather in January was the occurrence, under the influence of a low pressure wave, of fairly widespread rain over the Island from the 21st to 23rd. The rainfall was moderately heavy in the Eastern and Uva Provinces and among the central hills. The centre of this heavy rain was found in the southern parts of Batticaloa District, where several stations recorded about 10 inches of rain during the two days 21st and 22nd, resulting in floods which caused considerable damage to house property and paddy land and dislocated road traffic in Akkaraipattu-Amparai area.

North-east monsoon weather prevailed during the rest of the month, with rainfall confined mainly to the north-eastern hill-country and neighbourhood. This rain was, however, very much below expectations, especially on the north-eastern slopes of the hills, where the deficits for January were of the order of 10 inches. There were only two days, 1st and 19th, on which the rainfall was appreciably heavy. On a few days, when the monsoon conditions were weak, afternoon or evening thundershowers were experienced in the south-western parts. This rain was fairly heavy on the 15th.

Days of dry weather occurred, both at the beginning and at the end of the month. But the conditions at the end, from 25th to the end of the month, were exceptionally dry, with the result that the early mornings were unusually cold. The coldest days were the 30th and 31st, when the minimum temperature at Nuwara Eliya fell below the freezing point (32°F.), and the ground frost was fairly extensively formed.

The rainfall for the month was below normal over a large portion of the Island, excesses of any appreciable extent being found only in Batticaloa, Hambantota and Ratnapura Districts. At several stations over the Island, rainfall has been continuously in deficit during the last four months, 1952 October to 1953

January. As some of these receive a major part of their year's rainfall during October and November, they are badly affected by the drought conditions. The areas adversely affected include parts of the Northern and North-Central Provinces, Matale District and the north-eastern hill-country. As February is usually a dry month, there appear to be no great prospects of these areas getting adequate relief in the near future.

The biggest deficits during January were 14.64 inches at Hendon Estate, 14.00 inches at St. Martin's Upper, and 10.00 inches at St. Martin's Lower Estates and 11.83 inches at Nilloomally Estate, while the biggest excesses were 8.61 inches at Sengapodai, 7.71 inches at Timitar Estate and 7.50 inches at Irrakkamam.

The greatest monthly totals occurred on the north-eastern slopes of the hills where Lugaloya Estate recorded a total of 29.21 inches, St. Martin's Upper Estate 26.04 inches, Uva Estate 25.81 inches, and Hendon Estate 25.36 inches. Other stations in the north-eastern hill-country as well as some stations in the southern parts of Batticaloa District received over 15 inches for the month. Outside these regions there was a gradual decrease in rainfall, and the monthly totals in the western hill-country and in the north-western parts of the Island were below 5 inches. Least rain was experienced in Kegalle and Kurunegala Districts where the monthly aggregates at several stations were below 2 inches.

There were 25 daily falls over 5 inches in January, almost all of them occurring on the 21st or 22nd. The highest was 7.95 inches at Panawa Tank on the 21st.

Day temperatures were a little below normal in the north-eastern hill-country and above normal elsewhere, while night temperatures were, on the whole, a little above normal. The highest temperature recorded during the day was 93.2°F. at Ratnapura on the 13th, while the lowest temperature for a low-country station was 56.8°F. at Anuradhapura on the 30th and 31st and the lowest for the whole Island, 30.1°F. at Nuwara Eliya, also on the 30th and 31st. The mean day humidity was about 85 per cent. on the windward side, while it ranged from 70 to 78 per cent. on the lee side. The mean night humidity ranged generally from 85 per cent. to 95 per cent. Cloud amounts were above average and wind strength about average, the prevailing direction of wind being north-easterly.

D. T. E. DASSANAYAKE,
Director.

METEOROLOGICAL REPORT FEBRUARY, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Anuradhapura	88·6	+1·6	65·7	—3·8	66	95	3·0	1·66	4	— 0·06
Badulla	78·2	—0·8	62·8	—0·3	76	94	6·0	4·62	13	+ 1·45
Batticaloa	82·8	—0·1	73·5	—0·2	78	90	4·2	3·46	9	— 0·75
Colombo	87·5	+0·3	71·7	—0·4	69	88	3·8	7·20	10	+ 4·60
Diyatalawa	74·4	—0·4	56·4	—0·4	76	91	5·5	6·83	10	+ 4·46
Galle	84·3	—0·4	72·8	—0·9	76	88	4·1	7·81	13	+ 4·52
Hambantota	85·8	—0·2	72·6	—0·4	72	88	3·7	1·93	5	+ 0·47
Jaffna	85·7	+0·1	71·5	—0·8	67	90	2·8	2·45	3	+ 0·99
Kandy	86·6	—0·1	67·1	+0·2	62	87	3·4	2·30	6	— 0·01
Kankesanturai	84·8	—	74·8	—	71	81	4·0	3·19	3	—
Kurunegala	90·0	0	69·2	—0·5	56	87	2·8	3·58	4	+ 1·59
Mannar	86·5	+0·4	74·4	+0·6	71	90	2·8	2·78	3	+ 1·08
Nuwara Eliya	70·6	+1·1	45·3	+0·2	71	90	4·4	2·95	12	+ 0·96
Puttalam	88·9	+0·7	69·3	—1·0	66	93	3·1	4·28	7	+ 2·91
Ratmalana	87·0	—	71·0	—	69	90	3·8	5·52	11	+ 2·16
Ratnapura	92·6	+1·1	70·4	—1·0	65	93	5·0	5·08	10	— 0·22
Talawakele	75·9	—0·5	54·6	+0·1	65	78	3·0	1·79	5	— 0·18
Trincomalee	82·0	—0·5	76·7	+0·9	75	77	4·5	2·66	3	+ 0·01

WEATHER SUMMARY—FEBRUARY, 1953

EIGHTEEN days of continuous thunder activity is a very rare occurrence during February and March which are normally two of the driest months of the year. Such a spell of unusual weather, however, occurred this year. After a long period of almost absolute drought conditions during the first half of February, thunderstorms commenced on the 17th and continued till the 7th of March. They were mainly confined to the south-western parts of the Island and the hill-country, where, at many stations, although the day started with a clear and bright morning, afternoon or evening rain accompanied by thunder was a matter of course. Rainfall aggregates ranged from 10 to 20 inches, the highest totals including 18.94 inches at Matugama (Sirikandura Estate), 17.65 inches at Rangala (St. Martin's Estate), 16.30 inches at Avisawella, 15.66 inches at Labugama, and 15.17 inches at Neboda (Gikiyanakande Estate). Stations which experienced rainfall daily during this period included Colombo, Labugama, Neboda, Rangala, Watawala, and Yatiyantota.

From the 19th to 21st the rainfall was, more or less, widespread, while on the 21st it was, in addition, considerably heavy on the south-western slopes of the hills and the adjacent mid-country. Thunder activity has been very severe at times, being responsible for a few deaths and some damage to house and property.

In February, the larger monthly totals (of the order of 5 to 10 inches) occurred in the south-western parts, in the eastern parts to east of the central hills and in the southern parts of Batticaloa District, the largest being 16.02 inches at St. Martin's (Lower Estate), 14.63 inches at Hendon Estate, 14.46 inches at Irrakkamam, and 14.07 inches at Timitar Estate. Rainfall was below 2 inches in the north-eastern parts comprising Trincomalee and Mullaittivu Districts and a major part of the North-Central Province and in Hambantota District.

The rainfall was above normal over a greater part of the Island, the bigger excesses (of the order of 5 to 10 inches) occurring in limited areas in the western low and mid-country and in the southern parts of Batticaloa District. The biggest excesses were 9.59 inches at Irrakkamam, 8.87 inches at Timitar Estate and 7.72 inches at Gonapenigala Estate. Deficits were generally small (below 2 inches) and occurred in the north-eastern parts and to south and south-west of the central hills, the highest being 4.10 inches at Udugama, 3.61 inches at Weweltalawa Estate and 3.07 inches at Dabar Estate.

There were five daily falls over 5 inches in February, four of them occurring on the 21st, the highest being 8.40 inches at Pasyala on that day.

Day temperatures were above normal and night temperatures well below normal during the first half of the month. The mean values were rather irregularly distributed on both sides of average. The highest temperature recorded was 95.7°F. at Ratnapura on the 10th ; while the lowest temperature for a low-country station was 56.6°F. at Anuradhapura on the 14th, and for the whole Island, 30.7°F. at Nuwara Eliya on the 15th. The mean day humidity ranged from 60 to 70 per cent. in the north and north-west, while it was generally about 75 per cent. elsewhere. The mean night humidity varied from 85 to 95 per cent. Cloud amounts were above normal during the second half of the month. Wind strength was above average, the prevailing direction being north-easterly.

Ground frost was fairly extensively formed at Nuwara Eliya on the 15th.

D. T. E. DASSANAYAKE,
Director.

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not for human consumption

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The

Tropical Agriculturist

April to June, 1953

EDITORIAL

Food Production in Ceylon

IT is well known that though Ceylon is an agricultural country, its revenue is derived mainly from the export of the products of our plantation industries, tea, rubber and coconuts. On the other hand, though there are nearly a million acres of paddy and over 250,000 acres of arable or *chena* food crops cultivated annually, the Island imported in 1952 nearly 400,000 tons of rice and 210,000 tons of flour valued at Rs. 450 million in addition to various subsidiary foodstuffs such as chillies, onions and potatoes valued at over Rs. 60 million. This has imposed a severe strain on the national economy and has resulted in a very appreciable decline in the country's external assets during the past two years.

Government has, however, been fully alive to the extreme importance of increasing the food supply of the Island and to the necessity for making it largely, if not entirely, self-supporting in this respect. Since the inauguration of the Donoughmore Constitution when the representatives of the people were given the responsibility of framing the agricultural policy of the country, food production has received the highest priority in Government planning. Large irrigation schemes were initiated and a number of old schemes restored ; colonisation schemes were started in the dry zone under the most favourable conditions for the settler ; minor irrigation works were restored to the limits of the technical personnel available ; agricultural research on food crops was intensified and the extension services considerably enlarged ; a Guaranteed Price Scheme was introduced to ensure that cultivators got a fair price for their produce; facilities were offered to cultivators for obtaining loans for adopting improved methods of cultivation through the agency of Co-operative Agricultural Production and Sales Societies; and manure at subsidised rates, pureline seed at guaranteed prices and other concessions were granted to paddy growers. In short, every method that Government could reasonably conceive to promote food production has been put into operation.

The fact, however, remains that despite the measures adopted the increased output of food has hardly proved adequate for the annually-increasing population of about 250,000. Hence the extreme urgency to intensify our efforts in food production, if food imports are not to continue to be a severe drain on the resources of the country.

In this issue of "*The Tropical Agriculturist*" is recorded a full report of the proceedings of the meeting of the newly-constituted Board of Agriculture, presided over by the Honourable Minister for Agriculture and Food, Sir Oliver Goonetilleke, when the question of food production was discussed in all its aspects. This report merits the careful study of all those connected with the production of food in the Island, including not only Government officers responsible for this work, but also our administrators, our politicians, our rural leaders, our paddy landowners and our cultivators. It furnishes the views of those in the country who are best qualified to speak on the subject. The report is receiving the serious consideration of Government, though many of the suggestions made have already been adopted in a modified form. There are a few proposals, however, which Government can with advantage give effect to. Before recounting these, it would be of interest to review the present administrative setup in regard to food production in the country.

The Government organisations primarily concerned with food production are the Departments of Agriculture, Food Production, Irrigation, Co-operation, Marketing and Land Development, together with the Revenue Departments. The functions of the Department of Agriculture in this matter are primarily to conduct investigational work on the subject of food production and to put across the information to the people through its extension services. The Department of Food Production, on the other hand, is responsible for initiating and co-ordinating the activities of all Departments connected directly or indirectly with food production, and for implementing the policy of Government in regard to it. It is also responsible for the granting of the necessary funds to Revenue Officers and to C. A. P. S. Societies for various purposes connected with food production. There are two major agencies through which the work is carried out, namely, the District Agricultural Committee (D. A. C.) presided over by the Revenue Officer of the District and the C. A. P. S. Societies. In addition to the D. A. CC. there are co-ordinating Committees at the Divisional Revenue Officers' level and at the Village Headmens' level. These various Committees consist of nominees of the Departments concerned with food production, Members of Parliament (at D. A. C. level) and representatives of the agriculturists of the area. They fix the targets for agricultural production at the different levels and endeavour to achieve them to the fullest extent possible. The C. A. P. S. Societies, on the other hand, are entirely run by the cultivators and landowners under the guidance of Co-operative officers. Through them, loans at low rates of interest are made available to members for food production work, subsidised manure issued, tractors hired out at fixed rates, &c. To ensure that any food crops produced in the Island find a ready market a Guaranteed Price Scheme has been introduced and

this has been the greatest incentive towards increasing the output of food. The Marketing Department helps the drive by purchasing at fair rates vegetables, fruits, eggs, &c., and arranging the sale of other agricultural produce through the operation of the Agricultural Produce (Regulation) Ordinance.

The efforts made during the past few years in increasing our supplies of locally-produced food have not been without result. Recent statistical surveys of paddy yields conducted by the F. A. O. Statistical Adviser have shown that the average yields of paddy in the Island during *maha* 1951-52 and *yala* 1952 was about 30 bushels per acre each season. This figure is about twice that of the official yield previously recorded but the latter cannot be regarded as statistically accurate. There is little doubt, however, that our average yields of paddy can be appreciably increased by the adoption of the improved methods advocated and demonstrated by the Department of Agriculture. A glance at the results of some of the demonstrations carried out during *yala* 1952 which are published in this issue will clearly bear this out. It should, however, be pointed out that, although the practice of transplanting is undoubtedly conducive to greatly increased yields, there are a number of factors which limit its adoption in parts of the country, for example, an inadequate water supply at the proper time, shortage of labour, &c. But the alternate practice of harrowing the standing crop could advantageously be adopted in most areas. Manuring with artificial fertilisers is now becoming popular as a result of numerous demonstrations conducted throughout the Island. We can now look forward to an appreciable increase in acreage of manured paddy during the next season or two. A note of warning must, however, be issued, viz., that manuring will not prove economic unless it is accompanied by better tillage and weeding. There is every indication from the reports of the D. A. CC. that cultivators are rapidly adopting these improved practices largely because of the extension activities of the Agricultural Instructors, Food Production Officers and their assistants and the facilities Government has offered them.

For many years now the Agricultural Department has advocated the use of pureline seed as a simple method of improving yields. To this end its research workers have directed their efforts to evolve pureline strains suited to the various districts of the Island. Purelines suitable for the greater part of the dry zone have accordingly been produced and these have been multiplied on our stations or on private seed farms. During 1952 no less than 185,000 bushels of such pureline seed paddy were issued to cultivators. Recently, however, suitable purelines for the low-country wet zone have also been evolved and their multiplication has been taken in hand. The pureline paddy position in the country may, therefore, be said to be satisfactory and in two or three years the greater part of the Island should be adequately served with its requirements of such seed.

A new line of development which should have far-reaching effects on paddy production in the country is the introduction of machinery for ploughing, harrowing, &c., during recent years. This development has

resulted from the establishment of six tractor units by the Department of Agriculture during the past three years. These units undertake work for private parties at fixed rates, and during last year over 15,000 acres of private land were cultivated. C. A. P. S. Societies have since purchased a number of tractors for the use of their members and Government has also, either by gift or purchase, considerably increased its own quota of tractors. The total number of agricultural tractors in the Island may now be reckoned at over 800.

No account of food production in the Island will be complete without reference to the Paddy Lands Act which formed the subject of an editorial in the last issue of this Journal. It will suffice to say that this Act, when adopted, will be conducive to a greatly increased effort on the part of the tenant cultivator with consequent benefit to himself and to crop output in the Island.

To revert now to the proceedings of the Board Meeting alluded to earlier. A major suggestion made by many members was the great need for minor irrigation works throughout the Island. As an argument it was urged that while only Rs. 3 million were spent on such schemes Rs. 43 million were spent on major irrigation schemes during the past year. Another important proposal made was that the storage and irrigation ponds which were sited at the head of wet zone paddy tracts and which in the course of years had been obliterated, should be restored. The adoption of the latter proposal, even in part, should be of considerable benefit to the tracts in question. Other proposals related to the question of pest control and the stray cattle nuisance. Pest and disease control is well in hand consequent on the new insecticides and fungicides which are now available for the purpose. Through the co-operation of the Department's officers, Food Production Officers and C. A. P. S. Societies, this question should be effectively solved. For the stray cattle nuisance a satisfactory solution has yet to be found in many districts.

A brief reference to highland cropping will be necessary to indicate the considerable headway that has been made with the cultivation of chillies and onions in the country, particularly in the Northern Province. It is reckoned that over 45,000 acres have been brought under onions and chillies during the past two seasons. Were it not for the adverse weather conditions, there would have been a considerably greater acreage under these crops, particularly chillies. There has also been a marked increase in the production of gingelly and dry grains, largely owing to a guaranteed price for these commodities. The cultivator is fully aware of the benefits accruing from the production of such crops if an adequate water supply is assured him. Hence the demand for wells, particularly in the Northern Province. There are, however, factors severely limiting the increase in extent under these crops in areas where irrigation is not feasible and the cultivation is entirely dependent on natural rainfall. It is the function of research stations like that at Maha Illuppallama to ascertain the optimum conditions necessary for the successful cultivation of crops under dry

farming conditions. When this information is forthcoming, several dry farming colonies on the lines of the Kurundankulam and Relapanawa co-operative schemes can confidently be established and an appreciable increase of food produced.

Food production is a national enterprise and calls for the united and whole-hearted efforts of every individual and organisation, both official and unofficial, that can make a contribution to the quota of locally-produced food. It demands public-spiritedness of a high order from both land owners and tenant and owner cultivators on the one hand, and a high sense of duty, untiring energy and zeal on the part of the officers engaged in it, on the other. Given these conditions, our food supplies will become more assured with consequent benefit to the country and the individual.

ORIGINAL ARTICLES

Sorghum

BY

C. R. KARUNARATNE

INTRODUCTION

SORGHUM is also known as the Great Millet ; Idal Iringu or Karal Iringu in Sinhalese, Cholam in Tamil and Jowar in India. It is one of the oldest of cultivated crops, having being grown by Chinese earlier than 2,000 B.C. and by Egyptians in biblical times. This crop is extensively cultivated in China, India, Asia Minor. North and South Africa as a food crop and in Australia, America and in Southern Europe for stock feeding.

Although sorghum originated in the tropics it is now grown extensively in the temperate zones of both hemispheres. The bulk of the crop is grown south of the 40th parallel of latitude in the northern hemisphere and north of the 40th parallel in the southern hemisphere.

Sorghum is very extensively cultivated as a food crop in India, covering about 36 million acres. It is the second grain crop in Madras Presidency with 5 million acres. Sorghum grain is the main article of food of the rural population in the dry areas.

Although this crop stands next to paddy and wheat in India, nevertheless it had hardly spread in Ceylon, although it had been cultivated in one or two departmental farms since about 1930. This may have been due (1) to the difficulties of marketing the crop without creating a demand for the product, (2) to not guaranteeing the price, (3) the low price of paddy, (4) insufficient propaganda on the food value and the possibilities of this crop. The position has, however, remarkably changed with the present accute food situation and the consequent guarantee of a fair price for the grain, and the drive launched to popularise this crop.

CLIMATE AND RAINFALL

Sorghum being of tropical origin thrives in warm climates. This crop withstands extreme heat better than any other cereal and produces grain with a limited supply of moisture. It will also grow in districts of abundant rainfall, but wet weather may cause the development of mould in ear heads.

The crop can be grown on a wide range of soils, varying from light loams to heavy clay soils. The relative drought resistance of the crop allows it to be grown in soils of low moisture-holding capacity. Sorghum will thrive and produce good crops anywhere in the dry zone with a rainfall ranging

from 20 inches upward during the growing season. The crop being shallow-rooted, responds quickly to occasional showers of rain. It requires a fine moist seed bed for germination and early establishment. Sorghum crops offer better prospects than maize on soils of medium and poor fertility.

VARIETIES

Sorghum may be broadly classified into main types, (*a*) sweet or fodder sorghum, (*b*) grain sorghum. There is, however, no hard-and-fast difference between the sweet or fodder sorghum and the grain sorghum types. They inter-cross freely. Recognised grain sorghums may be tall and may have sweet and succulent stalks and leaves, and conversely sweet fodder sorghums are capable of producing high yields of grains. The classification is therefore vague.

Sweet sorghums are of a greater height, ranging from 6 to 12 feet, have juicier and sweeter stalks and leaves with a higher sugar content in the sap. The main consideration is the high bulk per acre and high quality and palatability of the bulk. The seeds generally range in colour from mahogany red to light brown and are bitter and unpalatable on account of their tannin content. Some sweet sorghums under cultivation on Departmental farms are Sweet Sugar Drip, Sweet Honey, Sweet Italian (introduced from Queensland in 1948) and Kavirondo. Of these Sweet Honey has proved to be outstanding.

Grain sorghums are of two types. Dwarf types with grain varying in colour from light to dark brown such as Plainaman, Kaprock, Kalo and Martin, are used for stock feeding. The best grain varieties used as human food are tall, and have white or creamy white grain. In fine varieties the grain has a pearly lustre and is plump and rounded as in the varieties Sanpyaung, Egyptian Corn, Tambagalla and Hegari.

According to the milling tests carried out by the Chemical Division, Egyptian Corn has proved the most satisfactory with 89% milling out-turn. The husks come out very easily and there is no appreciable breakage in grain. The flour obtained is very attractive. This variety has the added advantage of the grains being large which facilitates milling. Sanpyaung ranks a close second with 87% milling out-turn. The husks come off easily and there is no appreciable breakage in the grain, but the grain is small. The flour is attractive and good. As 475 has a milling out-turn of 89%, but the husk is tenacious and difficult to remove and the seed is small. The flour is attractive and good. Tambagalla has a milling out-turn of 78%, the husk is tenacious and difficult to remove. The flour is rather gritty and a bit astringent. Hegari has a milling out-turn of 80%. The husk is easy to remove and there is no appreciable breakage in the grain. The flour is grayish in colour and is a bit astringent.

Egyptian Corn and Hegari were introduced to Ceylon from Queensland in 1948 by the writer, and Sanpyaung by Mr. D. Rhind from Burma.

The ear heads in different varieties vary in shape and general construction in remarkable degree. They may be dense and hard, open and loose, very hard and densely packed, conical or much branched, or drooping or erect. The glumes in some varieties are not well developed and the grains are insecurely enclosed, whilst in others the glumes completely enclose the grain and adhere to it. Over 127 varieties have been identified in India alone.

Duration of growth is not a fixed character, for certain varieties when grown later than usual have a tendency to shorten the period of growth. Sorghum under irrigation matures more rapidly than when grown as a rain-fed crop. The crop is very sensitive to environmental influences and responds to even small variations in spacing and very considerably to manuring.

Five or six varieties of Sorghum were cultivated very successfully at the Agricultural Station, Wariyapola, during the period 1930 to about 1935 when the writer was in charge of that Farm. Thereafter the crop appears to have been completely abandoned. When the writer assumed duties as Divisional Agricultural Officer, North-Western Division, in September 1942, there were no traces of any sorghums at Wariyapola. On one of his circuits to Tambagalla village in Hiriyala Hatpattu he came across a few sorghum plants which strongly resembled one of the varieties that were cultivated at Wariyapola years ago. He brought the best ear head and multiplied this at Wariyapola and introduced it to the other farms. As the variety was found in Tambagalla village he named it Tambagalla. This is the variety now popularly cultivated all over the Island.

CULTIVATION

Early preparation of the land by ploughing with the first few showers of rain and thereafter keeping the soil harrowed three or four times to destroy weeds as these spring up until the seeds are sown, is very desirable. This will eliminate costly intercultivation operations after the crop is established. Sorghums like a firm, fine, moist seed bed for satisfactory germination and early establishment. The crop responds strikingly to manure, hence an application of three to five tons of farmyard manure, or $1\frac{1}{2}$ to 2 cwt. of fertilizer mixture will be very beneficial.

Seed rate varies according to the purpose of the crop. For grain crops the usual seed rate is 6-10 pounds per acre drilled in raws 18″ apart with the 3 coulter 18″ Indian seed drill. Where tractor-operated grain drills are available, as the planting rows of the drills are spaced in multiples of 7, it is possible to plant in rows spaced 14″ or 21″ by blocking the alternate rows, or two rows out of every three may be blocked where wider spacing is desired.

Spacing and seed rate trials conducted in Queensland have shown that during seasons of ample rainfall there may be little difference in yields from row spacings from 7″ to 3′ 6″ or seed rates from 20 lb. to 4 lb. Under such conditions the wider-spaced plants tend to tiller more freely and to produce larger ear heads, thus compensating for the higher plant population

obtained by closer spacing. Under drought conditions, however, the wider spacings have often enabled the plants to set a grain crop where closer spacings have failed entirely.

The main benefit of closer spacing and heavier seed rates is in the suppressing of weed growth, elimination of the necessity of inter-row cultivation, and reduction in soil erosion.

On poor soils, or in areas of light rainfall or heavy evaporation (as in the dry zone of Ceylon), wide between-row spacings of 28″ to 42″ have been advocated with a seed rate of 5 to 6 lb. per acre.

Close spacings ranging from 14″ to 21″ with a seed rate of 6 to 10 lb. per acre are more suitable for our conditions, as wider row spacings tend to encourage soil wash.

For fodder crops the seed rate is increased to 20-40 lb. per acre drilled in rows one foot apart. After drilling the seed it would be advantageous to cover and compact the soil by working a bullock-drawn plank harrow or the wooden Burmese harrow with the teeth removed, or a small Cambridge roller.

In India the grain sorghum crops are sown mixed with dhal, green gram, cowpea, black gram, mustard, gingelly, horse gram, castor and Deccan hemp. The subsidiary crops are sown in rows alternating with every three to five rows of sorghums. Sometimes the seeds are mixed with the sorghum and drilled. Under chena conditions the seeds would normally be broadcast as a pure or a mixed crop.

Early inter-row cultivation is necessary to give the crop a good start, and the first inter-cultivation is generally done about three to four weeks after sowing, when the seedlings are about four to six inches. The crop is sensitive to weed competition. When the crop is sown late after a hurried seed-bed preparation, weeds germinate along with the crop. The heavy and regular monsoonal rains that follow rule out possibilities of inter-row cultivation, with the result that the growth of the crop gets retarded by prolific weed growth. This difficulty can to a very great extent be overcome by early preparation of the soil with the inter-monsoonal rains and sowing the seeds with the first showers. When this is done it would be possible to intercultivate the crop at least once before the onslaught of the heavy rains. Scratchers attached to intercultivators to straddle the rows of seedlings will be very effective to nip off the small weeds in the rows. Frequency of cultivation depends on the weed growth, the aim being to keep the weeds well controlled. Two to three intercultivations should be sufficient.

When close spacing has been adopted, particularly in soils where weeds are a problem, it is advisable to harrow the young crop at right angles to the direction of the rows. This operation gives the plant an excellent advantage over weeds and the thinning out will be a decided benefit where the stand within the rows is excessively heavy.

When the crop is broadcast, the intercultivator with the teeth set wide should be worked lengthwise and crosswise through the crop when it is a month or six weeks old to clear the field and thin out the crop.

Harvesting should not be done until the bulk of the grain is thoroughly dry and cannot be dented with the finger nail. In America and Australia the ear heads are harvested by means of wheat header harvester machines. For this purpose dwarf varieties like Wheatland, Milo, Caprock, Martin, &c., have been evolved. The stalks are harvested for fodder purposes by means of maize binders. Where tractor-drawn mowers are available the sorghum crop can be mown down with mowers as is done on our major farms like Pelwehera and Maha Illuppallama. Bullock-drawn mowers can be used effectively if the mowers are fitted with scrub cutter bars. Where such machines are not available, sickles have to be used. The common practice is to harvest the ear heads first, and the stalks thereafter. The ear heads after being thoroughly dried on the threshing floor, are heaped up and left covered with gunny bags or straw for a few days to sweat out, and thereafter threshed. This facilitates the separation of the glumes from the grains at threshing. Different methods of threshing the grain are practised : (*a*) with power-driven machine threshers; (*b*) with the stone rollers drawn by pairs of bullocks; (*c*) by treading the heaps under the feet of bullocks; (*d*) by using a simple threshing implement made up of serrated discs mounted on a frame and operated by a pair of bullocks; (*e*) by beating the earheads with sticks.

The stalks are left on the ground for a few days to dry after being harvested. Thereafter these are tied into bundles of convenient size and left in stooks in the field for about a fortnight for further drying. Finally these are transported and carefully stacked, preferably under cover. Sorghum fodder carefully stacked will keep well for about two years.

Best time to harvest sweet (fodder) sorghum for ensilage purposes is when the grain is in the milk stage. It is not advisable to harvest sorghums before the flowering stage owing to the presence of hydrocyanic acid which is poisonous to stock. Sweet Sorghums cut at this stage may also be fed to stock as green fodder.

RATOON CROPS

Certain varieties tiller well and respond to ratoon cultivation. After harvesting the *maha* crop, if the stubble is intercultivated and a dressing of fertilizer applied, good ratoon crops can be gathered during the *yala* season. The stubble can be grazed off after harvesting the ear heads.

Yields vary greatly depending on soil fertility, incidence of rain, presence of pests, &c. Yields range from 20 to 60 bushels per acre. A good crop of fodder sorghum may yield from 25 to 30 thousand pounds of green fodder per acre.

SEED STORAGE AND PRESERVATION

Sorghums cross very readily and it is therefore advisable to sow only one variety if the purity of the type cultivated is to be maintained. Large ear heads with good plump seeds may be selected for seed purposes.

Sorghum grain is very susceptible to deterioration in storage, particularly in bulk storage, if it carries excessive moisture at harvest time. Grain with a moisture content of over 14 per cent. is certain to spoil if stored immediately.

Indian cultivators generally keep the selected ear heads for 3 or 4 months with occasional drying in the sun before it is threshed and stored away in wicker baskets daubed with cow dung and earth and whitewashed. The tops of the baskets are covered with pieces of gunny over which are spread some margosa leaves and a thin layer of ash and sand to keep off insects. Gammexane dusted on the top will repel insects.

Sorghum grain can be stored in common *bissas* used in villages for storing paddy. Precautions to ward off insect damage should be restored to by using Gammexane. It is very advisable to dry the seed once a month. The Indian cultivator dries his seeds as a rule on the New Moon days and for two or three days thereafter as he has a belief that the damage by insects is reduced to the minimum when dried during these days, but is great when dried a few days before the Full Moon. This belief is prevalent among our villagers, particularly in the case of felling timber for construction of houses, &c.

Indian cultivators store the sorghum grain in pits for two or three months to improve the taste and make it more wholesome. The pits are about $4\frac{1}{2}$ feet deep and $2\frac{1}{2}$ feet in diameter, situated in the open, close to their houses. Sometimes larger pits are used. The sides and bottom of the pits are lined with sorghum straw before the pits are filled with grain. The mouths of the pits are covered with slabs of stones and thereafter covered with earth. When the grain is required the pits are opened, the slabs of stones and earth are removed and kept open for two or three days to allow any noxious gases to escape.

PESTS AND DISEASES

The most serious pests that damage this crop are birds, particularly parrots. These have to be scared away. Villagers at times reduce the damage by breaking the stems and allowing the earheads to droop after the grain has passed the milk stage and until it matures. Sometimes they induce lodging the crop by rolling a stick over the crops after the earheads have passed the milky stage.

In storage the grain is very susceptible to attack by weevils. The growing plant is subject to attack by the stem borer, *Chilo simplex* which results in the death of the top stock. This can be controlled by rotating the crop. The grain is susceptible to attack by the fungus diseases Smut and Bunt when the flowering and ripening take place during humid weather. These diseases can easily be controlled by dusting the seed with copper carbonate, Ceresan or Agrosan at the rate of two ounces per bushel.

FOOD VALUE OF SORGHUM GRAIN

Sorghum grain is superior in food value to rice and only second to wheat. It is richer than rice in protein, and richer than wheat and rice in fat. The analyses of samples of sorghum, rice and wheat according to Dr. Aykroyd (Government of India Health Bulletin No. 23 of 1937) are given in the following table:—

Grain	*Moisture*	*Protein*	*Fat*	*Mineral matter*	*Fibre*	*Carbohydrates*
Sorghums ..	11·88 ..	10·42 ..	1·93 ..	1·76 ..	— ..	73·99
Rice-Raw milled ..	12·96 ..	6·82 ..	0·55 ..	0·50 ..	— ..	79·14
Wheat ..	12·77 ..	11·77 ..	1·45 ..	1·49 ..	1·20 ..	71·30

According to Joachim and Pandithasekera there is ample evidence to show that while there are slight differences between sorghum and other cereals such as rice and wheat, they are not large enough to make any significant difference in the food value of diets based on sorghum as the chief carbohydrate source. They give the following analysis for Ceylon grown cereals:—

Grain	*Moisture*	*Protein*	*Carbo-hydrate*	*Ether Extract*	*Fibre*	*Mineral*	*Calorific value per 100 m.g.*
Country Rice ..	13·24 ..	7·44 ..	77·28 ..	0·73 ..	0·33 ..	0·98 ..	345·5
Kurakkan	12·36 ..	7·61 ..	74·76 ..	1·35 ..	1·57 ..	2·35 .	341·6
Maize ..	12·81 ..	7·20 ..	73·76 ..	3·99 ..	1·20 ..	1·04 ..	359·8
Sorghum..	9·38 ..	7·57 ..	74·93 ..	3·92 ..	1·31 ..	2·89 ..	365·2

Sorghum grain seems to retain less moisture than rice which is an advantage. The protein, fat. fibre and minerals (ash) are somewhat lower than in rice. The protein is slightly lower than in wheat. Thiamine content has been found to be slightly above that of rice.

In a comparison of South African sorghum, Crawford, Hamersma and Marloth give the following figures:—

Grain	*Moisture*	*Protein*	*Fat*	*Fibre*	*Carbo-hydrate*	*Ash*	*Ca*	*Ma*	*P*	*Fe*
							(m.g. per 100 gram)			
Whole grain Sorghum ..	11·98 ..	10·36 ..	3·42 ..	1·96 ..	70·93 ..	1·35 ..	32·2 ..	122 ..	232 ..	6·6
Household Sorghum meal ..	11·91 ..	9·52 ..	2·72 ..	1·48 ..	73·27 ..	1·10 ..	38·4 ..	155 ..	225 ..	8·7
Wheat Flour ..	12·11 ..	11·29 ..	1·00 ..	0·21 ..	74·59 ..	0·44 ..	26·8 ..	17 ..	76 ..	2·3

" Analysis made by the Northern Regional Research Laboratory, Peoria—Illinois has shown that the amount of 13-Complex Vitamins in the grain sorghums compares favourably with that of corn. Riboflavin and pyridoxine are higher in corn, but more pantothenic and niacin and biotin are found in sorghum grain. The need for niacin by certain classes of animals and human beings has been well established " (Tanner, Fred W. Pfeiffer, Shirley E, and Courtis J. J. 13-Complex vitamins in grain Sorghums. Serial chemistry Vol. 24. No. 4 July 1947).

UTILIZATION OF THE CROP

Industrial. " During World War II large amounts of sorghum were used in America in the manufacture of alcohol which went into the production of synthetic rubber, munitions and other products to help win the war. The grain from waxy varieties is used in the manufacture of starch as a substitute for tapioca. This starch is highly regarded for sizing of paper and textiles and for adhesives. More recently great strides have been made in converting sorghum grain into starch that is further hydrolyzed into dextrose and syrup for which there is a large and growing demand. In this role sorghum starch comes directly in competition with maize starch. A large amount of starch now produced from maize, but which can be made cheaply from sorghum grain, is used extensively as a chilling mud by the oil industry of Kansas and other States. Oil, wax and protein feeds are valuable by-products that remain after the starch has been removed from the grain.

The possibility of using late-maturing sweet (fodder) sorghums high in sucrose as a source of crystalline sugar was explored in California in 1948 and 1949 with considerable success ".

SORGHUM AS A FOOD

For stock. All classes of stock make efficient use of sorghum in some form or other. As dry feed or silage, sorghum has played a prominent part in stabilising the beef and dairy industries of America and Australia. Feeding experiments conducted at the Hays Station in Kansas from 1945 to 1947 showed that, pound for pound, Westland and Midland sorghum grain were equal to corn as a fattening ration for beef cattle. Sorghum grain is as desirable as corn in a maintenance ration or as a concentrate for growing or fattening other livestock and for dairy production when it is ground and mixed with another cereal and a protein supplement.

In feeding grain sorghum to stock it is very advisable to grind coarsely, or to crush the grain, as otherwise much of it passes through undigested. Coarsely ground grain also improves the feeding value.

Whole grain may be fed to poultry in the grain ration up to 50 per cent. of the mash. It can be fed the same way as wheat meal or maize meal.

Cattle should not be allowed to graze off sorghum until the ear heads have been developed to avoid prussic acid poisoning. The stalks may be fed green, silaged or dried and stored as hay or straw. Sorghum hay or straw is far superior to rice straw.

As human food, grain sorghums, particularly the white grains, are very extensively used for human food in India, China and Africa in the form of meal. Coloured grains are bitter and not too palatable.

The processing of the grain and preparation of different foods may be done in the manner described below :—

Rice. The process of husking is not very different from that of ordinary rice but the following hints may be noted :—

Half a pint (a coconut shell full) of water may be added to every two measures of grain when pounding to facilitate the separation of the husk

from the grain. The first pounding will not produce a hundred per cent. husk free grain. But this has to be obtained by a second pounding of the grains that escape full treatment in the first. Addition of water in the second pounding may be avoided.

The percentage of broken rice (*hunusal*) will be about 10 per cent. This can be separated and may be used for preparing either flour or gruel.

The husk and bran left over after pounding could be used for feeding livestock.

Flour. Cleaned sorghum rice has to be first soaked in water for one hour. The water drained off and then pounded in the normal manner. The flour thus obtained may be roasted to prevent it getting rancid on keeping. If sorghum flour is to be milled out in large quantities. husking has to be done as described above before sending up to the mill.

SORGHUM RECIPES

Sorghum Rice—(S. Bath—T. Soru)

The cooking of sorghum rice is very similar to that of ordinary rice. The undermentioned points are important :—

(*a*) Whatever the quantity of rice taken up for cooking, care should be taken to see that a four-inch depth of water is maintained just above the rice level in the vessel. This quantity of water is sufficient for the complete boiling of the rice.

(*b*) The rice should be constantly stirred with a ladle so as to prevent the bottom layer getting charred and to bring about a uniform boiling.

(*c*) The fire should be reduced when the water has just gone below the rice surface and should be kept covered with a vessel to keep the flavour intact.

(*d*) Sorghum milk rice, yellow rice, buriyani and ghee rice can be prepared out of this rice in the usual way.

Sorghum String Hoppers

String hoppers are made in the same way as rice string hoppers. To give the string hoppers better taste and texture, knead the flour with coconut milk.

Sorghum Pittu

The method is the same as that of rice *pittu*. It is best to steam the *pittu* in bamboo moulds in the following manner :—

Instead of mixing scraped coconut and flour, it is best to put the flour and coconut in alternate layers in the mould to allow the steam to penetrate quickly.

This method of preparation makes serving also easy. To improve the flavour, food value and taste of *pittu*, black gram (*undu*) or cowpea flour may be added while kneading in the proportion of 1 : 4. Sorghum *roti*, *talapa*, *thosai*, *aluwa*, *welitalapa*, *kokis*, &c., can be prepared in the same way as these are prepared with rice flour.

Sorghum Gruel

Gruel can be prepared in a similar manner as rice gruel. In order to add flavour and food value to it, one may, according to personal taste, add roasted and split green gram or Bombay cowpea seeds, or groundnuts in the proportion of 1 : 4 of grain. Sugar or jaggery may also be added to taste.

Sorghum Roti

Fine sorghum flour is made into a dough by adding warm water. The dough is kneaded well into conveniently sized balls. These are spread out by hand into conveniently sized discs, about $\frac{1}{4}''$ thick, and baked on a hot pan. A small quantity of black gram flour, a pinch of salt, and if necessary a small quantity of coconut may be added to improve the taste of the product.

Thosai or Pan Cakes

Fine sorghum flour is ground into a paste by adding water. To this is added a small quantity of black gram flour also ground into a paste. Salt, chillies and onions are added according to taste. This is then converted into *thosai* by baking on a hot pan smeared with oil.

Sorghum as an Infant Food

Soak clean, good sorghum in clear water for a day and a night, changing the water three or four times. Thereafter heap the sorghum and keep covered with a wet cloth till the sprouts appear. Then spread it out evenly in a clean mat, occasionally sprinkling some water over it. When the sprouts are about $\frac{3}{4}''$ long, dry the sorghum in the shade for half a day and thereafter in the sun till it is quite dry.

Slightly moisten the dried grain and pound to remove the husks and sprouts, as the latter have a bitter taste. Then roast the clean grain over a slow fire till the grains turn just brown. Thereafter grind in a coffee mill or grinding stone and sieve through a muslin cloth.

The powder may be made into a conjee with milk or water adding salt and sugar to taste.

The malt may be added to other food as may be required.

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2—J. N. B 26661 (6/53)

Egyptian Corn—Sorghum.

Sanpyaung—Sorghum.

Tambagalla—Sorghum

Tambagalla—Sorghum

The Breeding and Cultivation of Maize

BY

D. E. SCHOKMAN

INTRODUCTION

BOTANICALLY catalogued as *Zea Mays*, and variously known as Indian corn, maize and mealies, this high yielding cereal is believed to have originated in Central or South America. The only known relatives of maize are teosinte (*Euchlena mexicana*) and gama grass (*Tripsacum* spp.). It is thought that maize developed as a cross between one of these and an unknown grass of the Andropogoneae, or as postulated by another school of thought it may have arisen from a wild pod corn. But as no wild or uncultivated maize is known among present or ancestral types its origin remains a matter for speculation.

Although maize was only introduced into the old world after the discovery of America, it can now claim to be one of the world's most widely cultivated crops; its distribution being chiefly confined within the fortieth parallels of latitude. Its uses both as a food and as a base for industrial preparations are varied and numerous, so much so that in America much money and time have been devoted to the evolution of new hybrid varieties with excellent yields. But in Asian countries where rice is the staple diet, maize is only casually cultivated and hence has received serious impetus towards improvement. This lethargic attitude is for the most part due to the fact that those accustomed to rice find maize hard to digest, and moreover, food preparations from maize take twice as long to cook as rice. Furthermore the peoples of the East have not yet realized the immense value of maize as fodder and silage for livestock.

With the ever-growing food shortage all over the world, however, and the increasing difficulty to procure rice imports, the accent has at last been placed on subsidiary food crops, and as such maize should take prominence in the future.

THE POSITION

The cultivation of maize in Ceylon has all along been restricted to the chenas of the Dry Zone, where it is grown chiefly as a mixed crop with kurakkan, and to small peasant holdings in the wetter highland districts. These maizes are all indigenous flint varieties of which there may be said to be three distinct types—red, yellow and white, yellow being the most common. However since no effort is made by the cultivator to select seasonally for seed and owing to the prevalent practice of growing numerous

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varieties concurrently in adjoining chenas and lots, natural hybridization over a period of very many years has almost obliterated all trace of definite varieties. Maize is normally cross fertilized and owing to the peculiar double fertilization which affects the endosperm, seeds show an immediate influence of a foreign pollen parent. A single crop will therefore exhibit a variety of differences in endosperm colour. Individual ears too will show colour combinations of yellow, red, purple and white.

The total accumulation of genes, however, in indigenous material seems to be disappointingly low, and flints as a rule are not heavy yielders. On an average the ears are large, but the seeds being round and shallow and the cob forming a comparatively large part of the ear, the shelling percent is invariably as low as 50-60, which compares most unfavourably with American dent corns that have shelling percents of 70-80. These factors taken all in all and enhanced by indifferent cultivation and manurial practices have resulted in poor quality maizes with notoriously low yields. Average yields of 15-20 bushels show up miserably when compared with bumper harvests of 40-60 bushels reaped in America, Europe and parts of Australia.

IMPROVEMENT

The immediate problem that confronts the breeder, therefore is the production of high-yielding, quality-grain maizes. Two obvious avenues of approach are suggested viz :

(1) The introduction of high-yielding maizes from other countries.

(2) The improvement of indigenous material.

THE CULTIVATION OF INTRODUCTIONS

In considering the feasibility of this approach, there arises the significant question of a adaptability. Maize though tolerant of a wide climatic range seems to be " latitude bound," and when transported outside its own latitude deteriorates in yield at once or over a few seasons.

The Department of Agriculture has experimented with such introductions from time to time with discouraging results. Of ten inbred lines obtained from Maryland, U.S.A., only four adjusted themselves to the new environment and the double hybrids derived from these inbreds have not proven themselves superior in yield to the local varieties. Three types of Italian flints were also tried in various parts of the Dry Zone with disappointing results. Recently four Javanese selections were grown at Agricultural stations, Katugastota and Tabbowa, and although high shelling percents and uniformly attractive ears, were very much in evidence, yields were not superior to outstanding local varieties of a comparable age. The

only introduction that seems to be thriving under local conditions is Australian Improved Yellow Dent, which has been grown very successfully since its introduction in 1948.

It is too early yet to attribute definite reasons for the success of this one variety in the face of the very mediocre performances of the others, but it will not be far wrong to surmise that maizes like Australian Yellow Dent derived from a more proximate latitude are able to adapt themselves to local conditions without a significant diminution in yield.

IMPROVEMENT OF INDIGENOUS MAIZES

The unflattering performance of the majority of introduced maizes focuses the attention of the breeder on the improvement of indigenous stock, which, though poor in quality and yield, is characterised by a high degree of vigour and resistance to unfavourable conditions. Stout culms and lush leaves are a feature of all Ceylon maizes. Three methods of improvement are possible :

(A) Selection

Firstly there is straight selection, where seasonal identification and isolation of promising plants within a local type is carried on till eventually an improved selection which is higher yielding and more uniform than the original local is produced. As a matter of fact such a selection known as " yellow maize " has long been recommended by the Department, and though it is superior in quality, yields are often only moderately better than local material. The paucity of genes in indigenous material restricts the value of this method and no striking results can hope to be achieved.

(B) Varietal Crossing

Secondly there is the method of varietal crossing on the American pattern, which consists of identifying pure lines by a system of inbreeding local material for several seasons till the desirable germ plasm is made known. Thus highly superior strains may be determined and used to produce either first-cross seed from two pure lines, or a double hybrid from four pure lines. If the inbred purelines are not closely related improved yields may be expected on account of the phenomenal hybrid vigour that is imparted to the maize in the event of crossing.

But once again the efficacy of the system is impaired by two major limitations. Hybrid maize as such owes its superiority to the ephemeral expression of hybrid vigour. Hence the constant production of first cross or double-cross seed, which has to be frequently made available to the cultivator requires a considerable commercial organisation. An idea of the labour involved may be obtained from the estimate that only 0.1 per cent. of the inbreds tested in the U.S.A. have proved suitable for the production of commercial hybrids. Success was not attained until co-operative programmes

involving several states were launched. The cost of breeding and maintaining the production of hybrid seed corn, therefore, may well be entirely uneconomic for a country like Ceylon with only a small maize acreage. Furthermore the low gene complex of indigenous material presents a poser to the evolution of strikingly high yielders by this method.

(C) **Top Crossing**

It is very evident then that any system which hopes to attain economically important results must involve a process, whereby the local material is graded up by an infusion of fresh germ plasm. It is here that introductions prove particularly valuable as reservoirs of genes.

This in fact is what is being attempted by the Division of Botany. Promising open-pollinated strains are being top crossed with introduced material with a view to combining potentialities for yield and quality derived from the introductions, with the high degree of vigour and adaptability that characterises the local flints. The ensuing hybrids are being rigorously tested on the following criteria :—

(i) Large, well filled and completely covered ears with not less than 14 regular rows.

(ii) Ears of uniform endosperm colour.

(iii) Superior yields with a shelling percent of not less than 70.

(iv) Increased vigour and a high degree of resistance to lodging, wind and stem borer.

Hybrids that show promise, but are deficient in any one or more of these requirements are further top-crossed to correct or improve such tendencies. Since the *yala* season of 1951, one hundred and eleven top crosses have been effected, of which the best that conform with the above standards are selected from time to time for further trial in the major maize growing areas.

It is too early yet to make any definite recommendations, but preliminary trials indicate a marked improvement in yields, uniformity of endorsperm colour, shelling percentage and the almost total eradication of ear-tip sterility. A reduction in age too has been achieved by crossing certain longer-aged local types with early Javanese varieties and American inbreds. The earlier types of maizes are particularly profitable for cultivation in the wet zone where shorter spells of dry weather obtain.

As yet only four Javanese varieties Stbno 1, 4, 7 & 124 and four American inbreds P 8, T 8, Tr & 38-11 and their derivatives (i.e. F1's three-way and double crosses) have been used in combinations with local material. It is proposed to include Australian Yellow Dent and Italian Yellow in

future breeding programmes. Since the encouraging results obtained so far augur well for future top-crossing, the introduction of fresh breeding stock from other countries is being considered.

Top-crossing, however, is considered a mere stop gap in America. When the demand for hybrid corn exceeds the supply, top-crosses are issued temporarily. For countries like Ceylon, however, where immediate increases in yield are sorely needed, but uniformity is of less importance at present, this method offers plenty of scope—till such time as superior local inbreds have been identified and successfully combined with foreign inbreds to give prosperous commercial hybrids. The production of indigenous hybrids must be the ultimate aim of any country hoping to obtain maximum benefit from the use of hybrid maize.

There is a popular fallacy that hybrids are extraordinary crops capable of high productivity even in poorly tilled and spent soils, so much so that when disappointing yields are realized under these conditions the faith of the peasant in the breeder is irrevocably shaken. It should be thoroughly appreciated by the cultivator that hybrids are not infallible productions against the usual deficiencies of soils and agricultural practice. In fact the heavier yielding hybrid maizes make greater demands on soil fertility and moisture than the open pollinated varieties. Where crop yields are limited by these factors the introduction of improved varieties would offer little advantage unless the existing primitive methods of cultivation give way to improved practices. Varietal improvement can find its fullest expression only under improved agronomic conditions. A general outline therefore of the more important agronomic aspects of the crop will not be out of place.

PREPARATORY TILLAGE

This will to a large extent depend on the nature of the soil, but as a rule a deep early ploughing, well in advance of the onset of the rains is advocated. Heavy clays and ill drained land should be avoided as much as possible, but, if used, should be ploughed to a depth of eight to ten inches.

But more important than soil type is tilth and soil structure. A fine seed bed ensures uniform stand and even maturity, and since there is an interaction between soil and climate, good soil conditions will protect the crop against adverse weather. This effect is further enhanced by the application of organic manures. The organic matter requirement of maize is high, hence a basic organic dressing should always be included in the preparation of the land.

The recommended practice is to harrow into the soil about five tons of compost or farmyard manure. But in the Dry Zone, where such bulky organics are scarce or are reserved for the cultivation of money crops like chilli and tobacco, a beneficial rotation should be implemented, whereby a green manure crop like cowpea, green gram or sun hemp alternates with the maize—the green crop being turned into the soil.

SEEDING TIME AND RATES

Maize needs a well distributed rainfall during its vegetative phase, with intermittent spells of warm, bright weather, and should therefore be planted with the first rains, or dry-sown early in expectation of the rains. Late-planted maize is invariably stunted and less vigorous. During its reproductive phase, however, dry weather is essential to ensure maximum seed set and proper ripening. Wet weather during the period of maturity facilitates the spread of disease, besides causing the crop to lodge. Tassel smuts (*Sorosporium reilianum*) and stalk and ear rots (*Diplodia zeae* and *Gibberella saubenetii*) can become quite troublesome as a result of late planting, causing an appreciable reduction in market value.

For *maha*, both in the Dry and Wet Zones, planting with the first rains in October is best. In *yala* (Wet Zone only), sowing should be done in April or early May depending on the advent of the rains.

The spacing of the crop will be largely controlled by the nature of the soil, age of the crop and the machines used for intercultivation. Longer aged varieties and richer soils demand a wider spacing. But, as a general rule, the following recommendations may be adhered to in average soils.

Grain maize (Drilled)—3′ between rows and the drills so adjusted as to drop seed at a spacing of 6″-9″ in the row.

Grain maize (Dibbled)—2′ × 1′ with one seed per hill or $2\frac{1}{2}$′-3′ × 1′ with two seeds per hill.

Seed rate—15-20 pounds per acre.

Fodder maizes are either broadcast or drilled in rows one foot apart. The plants in the row should be as close as possible. 30-40 pounds of seed per acre should suffice.

INTERCULTIVATION

This is a much neglected agricultural practice, though of the gravest importance if maximum yields are to be realized. Even more important than the actual stirring of the soil is the control of weeds, till such time as the crop is established well enough not to be seriously affected.

At least two intercultivations should always be given. In very weedy areas, however, a third may be necessary. The number and interval between intercultivations will vary with different localities, but the following schedule may serve us a guide.

(i) Two weeks after sowing (plants 6″-9″ high)—First intercultivation and thinning of plants.

(ii) Four weeks after sowing (plants about 1′ high)—Second intercultivation.

(iii) Six weeks after sowing—Earthing up with the Lister plough or with mamoties.

Earthing round the plants prevents lodging and in the case of listed areas conserves water, for although rain is detrimental to the crop during its later stages, a fairly high soil water requirement is necessary.

FERTILIZER PRACTICE

Maize is a very exhaustive feeder and the nutrient status of local soils being poor, it is very evident that spasmodic organic dressings and crop rotations are not alone sufficient to ensure maximum yields per acre. The incorporation with the soil of supplementary fertilizers to those who can afford it is therefore well worth the extra trouble and expense. The cost of purchasing fertilizers has been prohibitive to the cultivator in the past, but under the present Government subsidy it should be easier to popularise their use.

Ceylon soils generally lack nitrogen and phosphoric acid, but potash is found to appreciable extents except in the sandier areas. Hence a fertilizer mixture should include approximately equal proportions of nitrogen and phosphoric acid, and in sandy districts a small proportion of potash in the form of muriate of potash.

Proper fertilizer practice is a tricky business; the cultivator is therefore warned to seek technical advice as to the composition and method of application of mixtures in his particular area. Fertilizers may be applied broadcast along with the organic dressing or they may be given as split doses at the time of preparatory tillage and earthing up. The placement method is recommended in preference to broadcast applications, since fertilizer nutrients are made more easily available to the crop at the critical times when they are required. Further. the loss of nitrogen by leaching is minimised. In the placement method, the mixture is applied as a split dose in a band about two inches away from each row of plants, at the time of sowing and immediately before flowering. This method is particularly suitable for adoption in small holdings.

As a general rule the following mixtures may be considered for an acre of maize :

Dry Zone

1-1½ cwt. ammonium sulphate

½-¾ cwt. superphosphate (concentrated).

$1\frac{1}{2}$-2 cwt. ammonium sulphate

$\frac{3}{4}$-1 cwt. saphosphosphate or hyperphosphate.

In sandy districts $\frac{1}{4}$ cwt. of muriate of potash may be added to the mixture.

Nutrient deficiencies may be gauged from the behaviour of the crop. A cultivator who is capable of distinguishing the symptoms of such deficiencies is able to vary the proportions of a mixture to meet the demands of his crop. Premature yellowing or firing of the lower leaves from the tips downward is indicative of nitrogen deficiency. On the other hand purple colouring of leaves and stunted growth may be due to a lack of phosphoric acid. Potash deficiencies are not so easily discerned, but burning around the outer edges of leaves, a somewhat stunted growth and chaffy, poorly filled ears may point to the need for potash.

SEED SELECTION

The following season's seed should be selected within the standing crop from plants representative of the variety and area. Vigorous plants with stout straight culms should be favoured. Double eared plants bear more grain per plant than single eared plants, but the proportion is not double. One good ear per plant is certainly better than two mediocre ears, but where possible it is best to select from plants with two good ears. Ears should be completely covered by husks and borne on strong stalks. This if chiefly a selection against bird damage and unfavourable weather.

It has been found that longer ears yield more seed and that long, narrow grains are always associated with greater shelling per cent. The number of rows per ear seems to be immaterial as shown by research workers in other countries, who claim that the yield per row does not necessarily increase with number of rows in the ear. The ideal of selection therefore will be a long ear with large flat and deep kernels, borne in not less than fourteen regular rows.

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Fig. 1.—A fine example of hybrid maize obtained by top-crossing local material with introduced maizes.

Fig. 2.—A comparative study of selected and unselected maize showing the elimination of endosperm colour differentiation achieved by crossing.

Fig. 3.—Another comparative study of improved and indigenous maize.

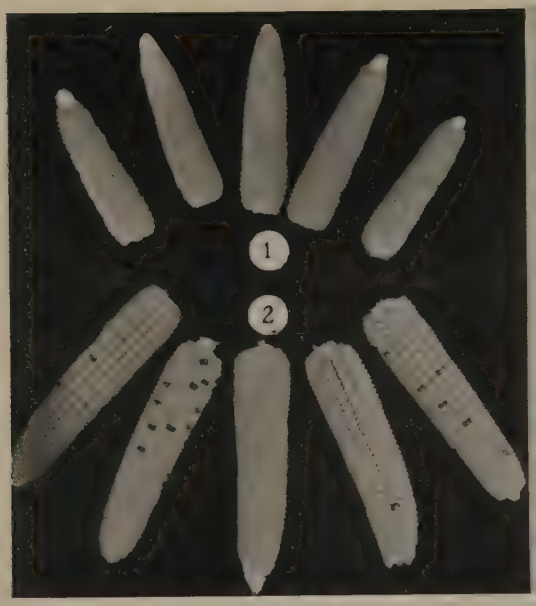

Fig. 4.—Hybrid flint maize (2) produced by top-crossing a local variety—W 1, with a Javanese strain—Stbno. 124 (1).

Fig. 5.—Hybrid dent maize (2) produced by top-crossing a local variety—M 2 (1), with introduced American inbred—TR.

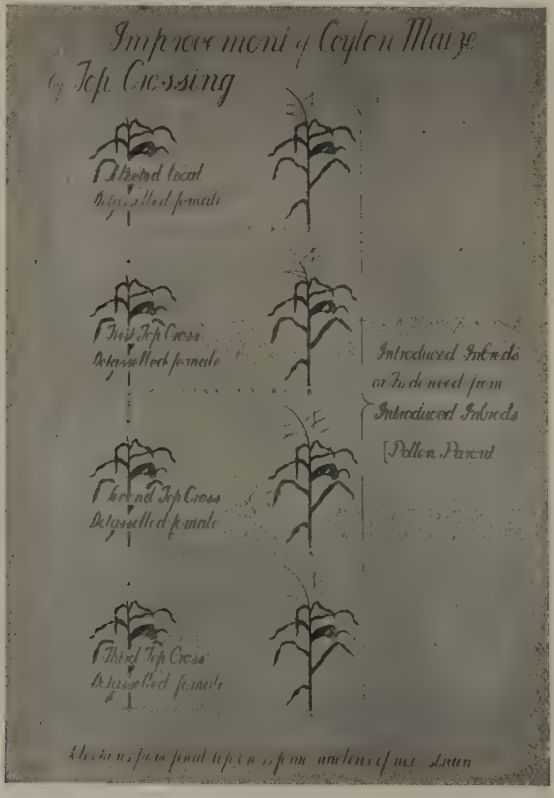

Fig. 6.—A diagramatic representation of the method being adopted by the Division of Botany to improve indigenous maizes.

Preliminary Observations on Transformation of Soil Nitrogen under Coconuts

BY

M. L. M. SALGADO and D. A. NETHSINGHE

THE seat of soil nitrogen is organic matter and a study of the transformations of nitrogen in the soil under various systems of cropping and cultivation is of fundamental scientific and practical importance.

Bemmer (1) in a review of recent work on soil organic matter remarks : " Considering the importance of nitrogen from the standpoint of soil fertility and the fact that about 98% of the nitrogen in most soils is organic, the nitrogenous organic complexes of soil have received surprisingly little attention. Very little definite information has been obtained regarding either their nature or their transformation in soil. " The nature of humus substances are yet obscure and hardly any investigations have been carried out on humus forms of hot climates. (Vageler (11), p. 131). At the recent Commonwealth Conference on Tropical and Sub Tropical Soils, Crowther stated " that little was actually known about the nitrogen cycle in tropical or any other soils, although many mechanisms had been invoked to explain gains and losses of soil nitrogen " ((3), p. 234).

It is generally accepted that the first stage of mineralisation of soil nitrogen is the production of ammonia from organic matter. The oxidation of ammonia in the soil takes place on the surface of the soil particles and it is only exchangeable ammonium ions that are oxidised. The next stage is the oxidation of the ammonia to nitrate and finally to nitrate.

It has also been assumed that in most arable crops absorption of nitrogen by the plant takes place in the form of nitrate.

" The nitrates are all dissolved in the soil solution, unless the soil dries out, but much of the ammonium is held on the exchange complex. The total quantity of mineral nitrogen in the soil is the difference between the rate it is being produced from the soil's store of organic matter by the soil population and the rate it is being removed by leaching, by growing crops and by other members of the soil population; and the proportion of nitrate to ammonia depends also on the rate of oxidation of ammonia to nitrates the uptake of nitrates by the plant and the loss of nitrates by leaching." (Russel (9), p. 292).

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Grasslands soils have the main proportion of their mineral nitrogen present as ammonia (Richardson (8) : Theron (10), a point that should be kept in mind under conditions of coconut cultivation, where there is a *temporary* ley of grass under coconuts that is normally biennially ploughed in and occasionally disc-harrowed.

On the other hand arable soils have a fairly constant but low content of ammonium nitrogen, but a variable nitrogen content ranging from 2 to 20 ppm. of nitrogen, as nitrate for normal soils, but according to Griffiths and Manning (4) rising even up to 500 ppm. for some tropical soils such as those in Uganda. Under fallow conditions there is a considerable accumulation of nitrates during the dry season, which however gets leached during the rains. Preliminary studies on Top Soils (0-9″ depth) taken in 1947 from plots of the N.P.K. manurial experiment on Coconuts at Bandirippuwa Estate had indicated a surprisingly high content of NH_4-Nitrogen, as shown in Table I :

TABLE I—(Date of Sampling, August 4, 1947)

No. of Plot	*Carbon Per cent.*	*Nitrogen Per cent.*	*C/N Ratio*	*NH_4—Nitrogen p.p.m.*
1	0·65	0·053	12·26	16
2	0·49	0·042	11·67	22
3	0·56	0·060	9·33	11

The more detailed observations recorded in this paper were made on three series of soil samples taken from a single plot (Plot No. 42) of the same manurial experiment on coconuts which had been continuing since 1935 at Bandirippuwa Estate. Manures have been bienially applied since November 1935 in circular trenches 3 feet wide, 6 inches deep, cut at a distance of 3 ft. from the palm. Immediately following manuring the land was ploughed. The last manuring and ploughing preceding the first soil sampling was in November 1951. Since the commencement of the manurial experiment in 1935 the plots were not grazed by cattle so that any complications due to the dropping of urine and dung does not arise.

Three series of soil samples were taken on 3.4.52 ; 19.4.52 and 27.6.52. Samples were taken outside the manure circle in two sets, one along the Rows of Palms (R) and the other in the centre of the squares (S) at four depths : 0-9″ (Top), 9-18″ (Sub_1); $1\frac{1}{2}$-$2\frac{1}{2}'$ (Sub_2) and $2\frac{1}{2}$-$3\frac{1}{2}'$ (Sub_3).

Composite samples from five borings were taken, stored in a wide mouthed bottle with a few c.c. of toluene to arrest bacterial action and analysed without delay. 2 more samples were used for analysis.

The soil was a deep loam, well drained overlying a subsoil of lateritic gravel much below the depth sampled. The pH and exchangeable base contents of the soil are shown in Table II.

TABLE II—Exchangeable Bases in Soil Samples from Plot 42

Sample No.	*Depth Horizon*	*pH*	*Total Exchangeable bases ME/100 gms.*	*Exchangeable calcium ME/100 gms.*	*Exchangeable potash ME/100 gms.*
RT	0– 9″		3·46	1·86	0·095
RS_1	9 –18″		2·83	1·66	0·026
RS_2	$1\frac{1}{2}$–$2\frac{1}{2}$′		2·75	1·82	0·056
RS_3	$2\frac{1}{2}$–$3\frac{1}{2}$′		3·73	2·31	0·030
ST	0 – 9″		3·38	1·96	0·095
SS_1	9 –18″		3·91	1·62	0·088
SS_2	$1\frac{1}{2}$–$2\frac{1}{2}$′		4·26	2·35	0·015
SS_3	$2\frac{1}{2}$–$3\frac{1}{2}$′		3·54	1·86	0·033

The rainfall data since the preceding manuring up to the last soil sampling are given below :—

	Inches	*No. of rainy days*		*Inches*	*No. of rainy days*
December 1951	1·84	10	April 1952	3·71	12
January 1952	4·10	7	May 1952	11·54	19
February 1952	4·70	6	June 1952	7·40	16
March 1952	·23	1			

On February 21, 1952, rainfall recorded was 3·16 ″.

EXPERIMENTAL

Total Nitrogen was determined by the Kjeldahl method. NH_4-Nitrogen by the Maclean and Robinson method (7), Nitrate nitrogen by the phenol-disulphonic method according to Harper (5) and nitrite by the Griess method.

DISCUSSION

The results are given in Table III and are of considerable interest. Contrary to the accepted views regarding the nitrogen distribution in arable soils, the following significant features will be noted : (*a*) the very high content of NH_4-Nitrogen, amounting to over 5% of the total nitrogen; (*b*) the high concentration of NH_4-Nitrogen in the subsoils, the amount in the 9″-18″ horizon being even higher than in the surface horizon, and the amounts at a depth of $2\frac{1}{2}$ to $3\frac{1}{2}$ ft. being quite appreciable ; (*c*) the very low concentration of Nitrate nitrogen except in the top soils of the series sampled on 3.4.52 ; (*d*) the consistent nature of the results in the three series of samples taken.

Bruce (2) in this studies on the periodicity of nitrification in a coconut area manured between rows of palms, found nitrates averaging 8.9 lb. per acre, but ranging from 1.0 lb. to 18.0 lb., the higher contents being present during the dry months. The basis of calculation of lbs. per acre is not stated; but on the usual basis of 2,000,000 lbs. of soils per acre the nitrate content averages 4.5 p.p.m. and ranges from 0.5 p.p.m. to 9.0 p.p.m. The total nitrogen of the manured area averaged on the same basis 221 p.p.m.

TABLE III—Total Nitrogen, Ammonium, Nitrate and Nitrite Nitrogen in Coconut Soil

(Plot No. 42, Bandirippuwa Estate)

	Series I—Collected 3.4.52			*Series II—Collected 19.4.52*				*Series III—Collected 27.6.52*			
	Ammoniacal N PPM	*Nitrate N PPM*	*Nitrite N PPM*	*Total N PPM*	*Ammonical N PPM*	*Nitrate N PPM*	*Nitrite N PPM*	*Total N PPM*	*Ammonical N PPM*	*Nitrate N PPM*	*Nitrite N PPM*
R Top	19·5	8	0·40	280	18·1	2	0·30	338	16·3	2	0·02
R Sub[1]	30·8	1	0·10	307	23·3	1·5	0·04	376	18·4	1	0·10
R Sub[2]	17·1	3	0·50	224	17·1	1	0·01	266	14·6	1	0·08
R Sub[3]	—	—	—	270	6·9	1	0·04	231	9·3	2	0·05
S Top	12·0	10	0·30	400	16·3	3	0·10	369	22·6	3	0·10
S Sub[1]	19·5	3	0·10	280	11·3	1·5	0·02	307	12·0	1	0·04
S Sub[2]	14·5	4	0·20	250	6·9	1	0·01	320	5·6	3	0·04
S Sub[3]	—	—	—	210	2·6	1	0·06	310	9·9	1	0·04

Data for the distribution of soil nitrogen for tropical soils are rare except for the useful observations of Laudelout and du Bois (6) based on studies of a savannah soil overlying a lateritic crust in the Belgian Congo given in Table IV.

TABLE IV—Nitrogen Distribution on a Savannah Soil (Laudelout and De Bois)

	Depth	*pH*	*Total N* Per cent.	NH_4–N *	NO_3–N *
Hill top	Surface	5·1	0·151	0·38	3·83
	20 cm.	5·2	0·100	1·82	1·82
Valley	Surface	5·1	0·108	4·54	9·40
	15–20 cm.	5·2	0·078	1·03	1·71
Lateritic crust	Surface	5·2	0·400	0·82	1·65
3 m. from crust	Surface	5·2	0·182	1·11	0·37
	10–30 cm.	5·1	0·155	3·11	3·46
8 m. from crust	Surface	5·1	0·157	1·08	3·24
	10–20 cm.	5·2	0·127	2·71	1·02
	40–60 cm.	5·1	0·110	0·34	22·63
38 m. from crust	Surface	5·1	0·147	0·70	0·35
90 m. from crust	Surface	5·1	0·147	2·59	0·74

* These are presumably p.p.m. though not specifically stated in the paper.

In this case however, except that the ammoniacal Nitrogen is always higher in the illuvial than in the surface horizon, its content is on the average low compared to the amounts of nitrate.

Similar studies based on samples taken from Kirimetiana Estate, Lunuwila, where the pasture had been heavily grazed by cattle, confirm the presence of high contents of amoniacal nitrogen in coconut soils. Nitrates in fact could not be detected in this case. The samples were however, taken to a depth of 18″ only.

TABLE V—Ammoniacal and Nitrate Nitrogen of Soils

Kirimetiana Estate, Lunuwila
(Sampled 20.8.52)

		NH_4	*Nitrate N*
Row Top	0– 9″	15·8 ppm.	nil. ppm.
Row Sub	9–18″	18·6	nil
Square Top	0– 9″	19·3	nil
Square Sub	9–18″	20·1	nil

Until further work is done, it is difficult to offer an explanation for the high contents of NH_4-Nitrogen and its distribution in the profile, observed in the coconut soil. Although Laudelout and du Bois (6) state that there is no explanation for the observation that Ammoniacal-nitrogen is

higher in the illuvial horizon than in the surface horizon it is possible that the exchangeable amonia gets hydrolysed and leached to the lower layers where it accumulates.

A recent paper by Theron (10) entitled " The influence of plants on the mineralisation of nitrogen and the maintenance of organic matter in the soil " is of particular interest in this discussion. Under tropical conditions, where no legumes take the place of clovers of the temperate humid areas, Theron concludes that grass depresses the mineralisation of soil nitrogen to nitrate. In a series of pot experiments with a perennial grass, no nitrates were found, but there was a tendency for ammonia to make its appearance in quantities larger than is normally found in cultivated soils. The nitrogen present as exchangeable ammonia was about 6 p.p.m. while nitrates rarely exceeded 1 p.p.m. According to him, the oxidation of the ammonia to nitrates is interfered by the grass, caused by bacteriostatic excretions by living roots which paralyse the autotrophic dehydrogen system of the nitrifying organisms without interfering with the process of ammonification. According to Theron " This hyphothesis offers an explanation for the rather unexpected presence of ammonia under grass and it leaves a channel open through which perennial crops can obtain nitrogen, namely, by way of ammonia produced in the normal course of ammonification. The view expressed by Richardson (8) that the grass herbage takes up most of its nitrogen as ammonia is of interest in this connection."

Is it possible to speculate that under the system of cultivation of coconuts, where a temporary two year ley of grass is maintained under the palms, and the accumulation of ammoniacal nitrogen as shown by our data occurs, the root system of the coconut palm absorbs a considerable amount of its nitrogen requirements in the form of ammonia and not as nitrate?(*)

A more detailed study following up the nitrogen transformations after ploughing in the grass would be necessary. The data recorded commence with the first sampling only four months after ploughing in of the ley. In a recent estimate based on quadrat samples obtained from different plots of this manurial experiment, it was calculated that on the average 1.6 tons air-dried material, containing 39 lb. nitrogen are turned into the soil per acre. The grass soon re-establishes itself, but how far the decomposition of this organic matter influences the distribution of the different forms of nitrogen in the soil and in the nutrition of the coconut palm remain to be investigated.

Similar studies should also be made on other soil types on which coconuts are cultivated.

Nitrogen happens to be the most expensive of the artificial manures used on coconut estates. Systematic studies of the nitrogen cycle under coconuts should be valuable in rationalising the nitrogen economy of the coconut palm.

(*) Hutchinson. H. B. and Miller, N. H. J.—Direct assimilation of ammonium salts by plants. J. Agri. Sci. (1908-10), Vol. 3, 178-193.

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The Potato Tuber Moth

Gnorimoschema operculella (Zeller). (Order Lepidoptera)
Family Gelechiidae

BY

P. MANICKAVASAGAR

INTRODUCTION

POTATO (Solanum tuberosum L., Arthapal S., Urulai Kilanku T.) has been cultivated in Ceylon on a small scale in garden plots in the Badulla and Nuwara Eliya Districts for the last forty years. During the last two years the cultivation of the crop has been carried out on a larger scale. Consequent upon the recent intensification of potato cultivation more effort has been concentrated on the study of the pests and diseases of potato in Ceylon. A caterpillar attacking potato tubers in storage was first recognised on November 13, 1951, at the Potato Station, Rahangala. The pest was tentatively identified as the potato tuber moth, Gnorimoschema (=Phthorimoea) operculella (Zeller), an identification which has been confirmed by the Commonwealth Institute of Entomology, London.

The potato crop in Ceylon is chiefly cultivated between an elevation of 3,000 and 6,000 feet where the temperature is 70° to 80°F. The crop is also being tried out in various parts of the low country dry zone. Surveys of the potato crops in the Udukinda and Nuwara Eliya ranges during the course of nearly a year since the tuber moth was first recognised indicate from the very rapid build-up of pest populations during this period, that the pest was very recently introduced into Ceylon, probably during the last two years.

DISTRIBUTION

The potato tuber moth has been a serious pest of potatoes in the United States for the last 28 years. It has also been recorded in Australia, Holland and other leading potato growing countries of the world. In Ceylon it is present in almost every plot of the potato crop.

HOST PLANTS

Most cultivated Solanaceae and weeds of this family are attacked by the pest. Among these potato, tobacco, tomato and egg plant are attacked in U. S. A. In Ceylon however the pest has been found attacking only potato

on the field. Artificial infestation of chilli, tomato and tobacco plants with the pest in the laboratory have been carried out and the results have shown that heavy attack is only possible on tobacco. On chillies and tomatoes the attack is restricted to leaf mining and on no occasion did the pest complete its life cycle. On tobacco on the other hand the attack is vicious and appears in the form of leaf mining and stem boring. This point is of special importance and should be seriously considered when tobacco is to be grown in potato growing areas.

NATURE OF DAMAGE

The larvae are responsible for the damage of potato plants and tubers. Healthy growth is retarded by the pest mining between the upper and lower leaf surfaces, causing unsightly grey to brown blotches (Fig. 1 a and b), and thus bringing about low yields. The tunnelling by larvae within tubers render such tubers unfit for human consumption.

DESCRIPTION OF STAGES

Adult

The insect which does the damage to both foliage and tubers is the caterpillar of a very small, narrow winged, brownish grey moth, with dark brown streaks on the fore wings (Fig. 1 g). The fore wings as well as the hind wings are fringed with long hairs. The moths measure $\frac{1}{2}$ inch from tip to tip of the wings. The antenae are simple and filiform. The moths are nocturnal in habit and hide under the leaves of the host plant during day time, and fly out only when disturbed. Their wings are folded tightly along the sides of their body while at rest. The antenae are also held parallel to the body pointing backwards (Fig. 1 h). In captivity the female moths, after mating commence oviposition within 1 to 3 days after emergence. Oviposition lasts for 2 to 4 days. Gravid females lay between 78 and 172 eggs. The gravid females and mated males live for 6 to 10 days after emergence. But the unmated females and males live for 10 to 28 days.

Eggs

Eggs are small pearly white oval and measure about ·25 mm. They are usually laid singly on the undersides (Fig. 1 c) of the leaves along midribs, veins, junctions of veins and eyes of tubers. Generally, the moths prefer to oviposit in small cracks and crevices. The generation of moths emerging a few days prior to harvest tend to lay their eggs on the exposed and discarded tubers in the field. The egg is covered with soft adhesive material on the chorion, which serves to glue it to any surface. At times the eggs are slightly embedded in the epidermis of the plant tissues. The eggs turn yellowish before hatching. The caterpillars emerge in about 4 to 5 days time.

Larva

The freshly emerged larva is about ·5 mm. long (Fig. 1 e) pale, creamish with a well marked black head. In the case of stored potatoes the first instar larvae wander over the tubers for a few hours. They then gradually mine into the tubers first under the skin of the tuber (Fig. 1 d), and later tunnel through the flesh, leaving a compact trail of frass and silken web behind them in the galleries. The first instar larvae can enter very young tubers at any spot, but in the case of mature tubers the points of entry are restricted to the eyes or to bruised spots. On the field the larvae on hatching, mine into the leaves, feeding on the leaf tissues but leaving the upper and lower surface intact. The larvae may also mine through the stems, sometimes reaching the tubers underground. The caterpillar when full grown measures 9 to 10 m.m. in length, having a well chitinised dark brown head, two black plates on the pro-thorax, a pinkish mesothorax while the rest of the body is pinkish dorsally and light greenish on the flanks. Very minute hairs are present on the intersegmental regions. The larval period lasts for 13 to 15 days.

Pupa

The full grown caterpillar before pupation, comes out of the tuber and spins a tough silken cocoon in the frass (Fig. 1 f) pushed out of the galleries, on the surface of the shrivelled up potato. In the case of the caterpillars mining leaves and boring stems, they come out and pupate in the folds of damaged and dead leaves or among trash on the ground. Prior to pupation, the caterpillar shrinks, and the colour changes to greenish blue. The pupa is first pale blue in colour and in about 24 hours become brownish, gradually changing to dark brown. The pupa measures 6.25 to 7.25 m.m. Pupation lasts for 8 to 10 days.

CONDITIONS FAVOURABLE FOR DEVELOPMENT

Warm and dry weather conditions seem favourable for the fast development of the pest. In very warm weather, a healthy crop could be destroyed within two weeks, leaving only the bare stems.

The pest being a leaf miner is not very much affected by the rains. It could complete its life cycle in one leaf alone.

PARASITES

Copidosoma Koehleni. Blanch, a larval parasite of the tuber moth had been recorded in Chili (2).

The larvae of the tuber moth have proved to be ideal insectory hosts for the mass production of Macrocentrus ancylivorms Poh (I) which is used to control the oriental fruit moth (Grapholitha molesh (Busch)) in the

U. S. A. The use of the tuber moth larva as a medium for propagation of Macrocentrus ancylivorms permits production the year around with a minimum of labour and space.

CONTROL

Various insecticides have proved effective in the control of the pest both on the field and in the store. Benzene hexachloride imparts to the harvest of treated potato plants an odour and disagreeable musty flavour (3). In Ceylon, preliminary insecticidal treatments showed a very effective control of the pest by the application of DDT sprays on the field and DDT dusts in the stores. Insecticidal trials have been commenced by the Entomologist to determine the best insecticide and details of its application to effectively control the pest under Ceylon conditions.

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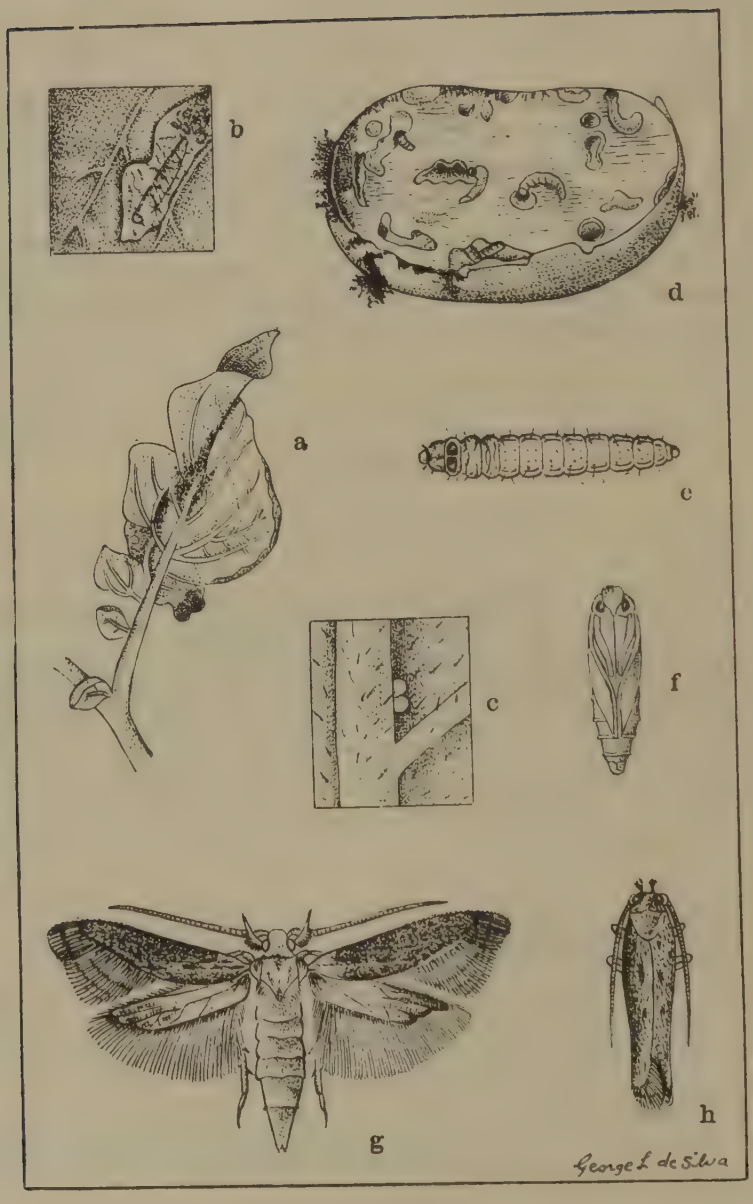

Fig. 1—a, Damage of potato leaves by caterpillar; b, caterpillar mining in potato leaf; c, 2 eggs of tuber moth on under side of potato leaf; d, potato tuber attacked by caterpillars showing larval gallaries, larvae and pupae; e, mature caterpillar; f, pupa; g, tuber moth with wings spread; h, tuber moth in resting position.

(a and d, natural size; b, about twice natural size; c, about 15 times natural size; e, f, g, h, 5 times natural size).

Crossbreeding Experiments with Sinhala Cattle at Karagoda–Uyangoda

BY

P. MAHADEVAN

INTRODUCTION

THE birth of the first generation hybrids in April, 1953, from the Jersey—Sinhala matings at Karagoda-Uyangoda, has aroused considerable interest among local livestock breeders on the subject of crossbreeding. Speculation is rife in some quarters as to the future breeding policy that may be adopted with the hybrids, while dark forebodings emanate from others about the usefulness of crossbred stock for breeding. It is the purpose of the present article to show the fallacy behind the usual warnings never to breed from crossbred animals, and to outline the experimental breeding programme that has been drawn up for Karagoda-Uyangoda.

THEORETICAL

It is generally argued that the mating of crossbred to crossbred results almost inevitably in the production of a heterogeneous population varying unpredictably in yield, size, conformation and constitution and with no fixed characters. This classical objection to crossbreeding is based on the Mendelian law of segregation which states that when the hybrid reproduces, it transmits with equal frequency either the domniant character of one parent or the recessive character of the other. It is therefore important to emphasize at the outset that Mendel's law of segregation strictly applies only to characters that are under monofactorial control. An example of such a character in cattle is the presence or absence of horns.

Characters of economic importance such as those listed above (i.e., yield, size, conformation and constitution), are, however, dependent on a large number of genes, whose individual effects cannot ordinarily be isolated and are not necessarily equal, and whose phenotypic expression is to a great extent subject to environmental modification. The hereditary transmission of such traits has been referred to as polygenic inheritance by Mather.

For characters under monofactorial control, the law of segregation would cause the variation in the F_2 to be considerably greater than in the F_1 ..... In general, the magnitude of this increase in variation is dependent on (*a*) the difference between the original parent stocks, (*b*) the umber of genes involved, and (*c*) the heritability. Increased

variation in the F_2 over the F_1 would be expected when the difference between the parent stocks is large, when the number of genes involved is small, and when the heritability is high. But, for characters which are dependent on a large number of genes and which have a low heritability, there would be little or no increase in variation in the F_2 over the F_1, irrespective of whether the difference between the parent stocks is or is not large.

Certain parameters have to be laid down before we could calculate the results that may be expected from crossbreeding for milk production. We will assume on the basis of the available evidence that the coefficient of variation of milk yield is generally around 20 per cent. We will also assume that the heritability of milk yield is 25 per cent., as different investigators have arrived at estimates of heritability that lie around this figure. Using these data, the probable results under different genetic situations, of matting F_1 hybrids *inter se*, could now be determined.

Let us suppose that a cross is made between a Jersey with potentialities for a first lactation yield of 400 gallons of milk and a Sinhala with corresponding potentialities for 100 gallons. The F_1 would then be expected to give an average yield of 250 gallons, which is intermediate between the yields of the two parental breeds, while the standard deviation would be around twenty per cent. of the mean yield viz., $250 \times \frac{20}{100} = 50$ gallons.

Let us now suppose that these F_1 hybrids are mated *inter se*. If the difference in milk yield between the original parent breeds was due to one gene (A) only, we would have the following genetic situation :—

P_1	Jersey AA (400 gal.)		X		Sinhala aa (100 gal.)
F_1			Aa (250 gal.)		
F_2	$\frac{1}{4}$ AA (400 gal.)	.... 150 gal.	$\frac{1}{2}$ Aa (250 gal.)	.... 150 gal	$\frac{1}{4}$ aa (100 gal.)

Since the heritability of milk yield is one quarter, the genetic variance in yield in the F^2 in the above case would be $\frac{1}{4}(150)^2 + \frac{1}{4}(150)^2 = 11{,}250$ gal.^{2}

The environmental variance would be $(250 \times \frac{20}{100})^2 = 2{,}500$ gal.^{2}

$\therefore$ Total variance of the $F_2 = 11{,}250 + 2{,}500 = 13{,}750$ gal.^{2}

$\therefore$ Standard deviation of the $F_2 = 117$ gallons.

This measure of the standard deviation of the F_2 is based on the assumption that the difference in milk yield between the parent breeds was due to a single gene.

Let us now consider the consequences to be expected if we assume that the difference in milk yield between the parent stocks was due to 5 genes with equal effects instead of being due to 1 gene only.

The variance of the F_2 due to each of the 5 genes would then be $\frac{1}{4}(30)^2 + \frac{1}{4}(30)^2 = 450$ gal^2.

$\therefore$ Total genetic variance from the 5 loci = 2,250 gal^2.

The environmental variance would be $(250 \times \frac{20}{100})^2 = 2,500$ gal.^{2}

$\therefore$ Total variance of the F_2 = 2,250 = 4,750 gal^2.

$\therefore$ Standard deviation of the F_2 = 69 gallons.

Summarising the above results, we have :

(i) Standard deviation of the F_1 = 50 gallons.

(ii) Standard deviation of the F_2 = 117 gallons on the one gene hypothesis
= 69 gallons on the five gene hypothesis

It is evident from this that when the character being considered is monofactorial, the variation in this character in the F_2 would be considerably greater than in the F_1. But, when the number of genes influencing the character is 5 instead of 1, the increase of variation in the F_2 would be much less. As the number of genes affecting milk yield is far greater than five, it is easy to see why the variation in the F_2 cannot be very different from that in the F_1.

These theoretical findings based on modern concepts of the inheritance of polygenic characters provide ample proof to vitiate the usual warnings that one should never breed from crossbred animals. Practical confirmation of these findings from the current cross-breeding experiments at Karagoda-Uyangoda which we shall now outline, will be awaited with considerable interest.

EXPERIMENTAL

The need for a well-planned cross-breeding experiment with the Sinhala cattle as the foundation stock has been repeatedly emphasised in previous issues of this journal (Tropical Agriculturist Vol. CVII. No. 3, No. 4, and Vol. CVIII. No. 4.). It may be estimated that over 90 per cent. of the cattle population of Ceylon belongs to different indigenous types, and it is therefore clear that the most economical way of effecting any large scale improvement of cattle in this country is by using the indigenous cattle as the foundation breeding stock. Importation of cattle from overseas to replace all the indigenous animals is an obvious impossibility. Furthermore, it has been shown that the rate of genetic improvement possible by selection within the indigenous stock is such that " it would take us over 200 years to raise the average level of production of the Sinhala cattle in Ceylon to anything comparable to the yields given by Jersey cattle under local conditions ". The crossing method has therefore been advocated as one that would give a worthwhile increase at the start which could later be built on by the usual selection methods.

The cross-breeding project at Karagoda-Uyangoda was initiated in 1952 in accordance with the above ideas. The first year of the experiment has been devoted to the mating of some 50 Sinhala cows at this station to Jersey bulls. The selection of bulls from Jersey breed for this purpose was motivated by the fact that of all the locally available European breeds,

the Jerseys are perhaps the most tolerant to high atmospheric temperatures and high humidities. This may be due partly to their small size and partly to their low body weight to surface area ratio. Be it as it may, it is nevertheless evident that if some of the crossbred progeny are to be backcrossed to Jersey, as envisaged at present, the need for a high heat tolerance mechanism in the animals may well arise. This was one of the main reasons why the Jerseys were awarded first choice in this crossbreeding project.

During the second year of the experiment commencing about July 1953, the Sinhala cows that were mated to Jersey bulls in the first year would be mated to Friesian bulls. The Friesian is undoubtedly the most high yielding of all breeds of dairy cattle in this country, with the disadvantage, however, of very low physiological adaptability to climatic stress. It is therefore anticipated that backcrossing of the F_1 hybrids to the exotic parent breed cannot be carried as far in the Friesian crosses as in the Jersey crosses.

The third year of the experiment would be devoted to the mating of the foundation Sinhala cows to a third breed, not definitely determined as yet. The choice of this breed would depend partly on the preliminary results of the breed-environment interaction experiments that are being conducted at present with different Indian breeds of dairy cattle, and a similar experiment envisaged for the Ayrshires and Shorthorns. Whatever the outcome of these experiments, this third breed will be the last of the exotic breeds to be used in the crossbreeding project at Karagoda-Uyangoda.

It may thus be seen that three sets of F_1 hybrids would be produced by mating the same Sinhala cows to different breeds of bulls during the first three years of the experiment. By this method, the greater part of the genetic variance in yield between the three sets of F_1 hybrids could be attributed to the differences between sires and to the differences between breeds to which the sires belong.

It should also be possible within the limits of experimental design to gather some knowledge on heterosis. To obtain satisfactory results on this, two designs are possible. One consists of using several bulls of each breed so that the males and females used in producing the purebreds and crossbreds are a random group of their breed. The second possible design is to use as few bulls as possible of each breed and to make the cross reciprocally. At Karagoda-Uyangoda, in addition to mating Jersey males to Sinhala females, some reciprocal crosses are also being made with Sinhala males and Jersey females. Further, a programme of purebreeding with Sinhala males and Sinhala females is also being conducted as a parallel to the crossbreeding project. In the Friesian—Sinhala matings, owing to difficulties of acclimatisation of Friesians to Karagoda-Uyangoda conditions, it is not proposed to conduct any reciprocal matings. But, as many Friesian males as possible would be used for crossing.

The breeding programme envisaged for the F_1 hybrids is designed to throw light on the feasibility of stabilising the F_1 and also on the effect of increasing the quantity of " foreign " blood. Each F_1 group (Jersey—

Sinhala, Friesian—Sinhala, &c.), would be divided in two, and one part would be mated *inter se* while the other would be backcrossed to its exotic parent breed. This would give rise to the F_2 and B_1 generations, with the latter containing as much as 75 per cent. " foreign " blood. It may be that the B_1 animals, especially those resulting from Friesian matings, although capable of a reasonable level of production, may not have the stamina and adaptability of the indigenous Sinhala stock. .....
It is also possible that increasing percentages of " foreign " blood may have some effect on fertility, calving interval, and general health. These effects would have to be evaluated very carefully when comparing the performance of the F_1, F_2 and B_1 animals in all groups.

The subsequent breeding of the F_2 and B_1 animals would be determined largely by their own performance. It is however anticipated that over the period of the experiment, sufficient data would be collected to give a quantitative picture of the effects of introducing, into the Sinhala cattle, different quantities of Jersey, Friesian, and other " foreign " blood. It should then be possible to decide on the most desirable combination of " foreign " and " local " blood, so that, thereafter, sires possessing this combination and coming from high producing dams could be selected for breeding. In this connection, it may be noted that Lecky (1950, personal communication) makes the following statement regarding the Hope Jersey, which is a new breed of dairy cattle produced in Jamaica by crossbreeding : " The work indicates that selection based on milk yield is a better method than that based on adaptability. Selection based on yield tends to favour animals which are sufficiently adapted and have the necessary genes for high production. On the other hand, selection based on adaptability would favour animals with most Zebu blood without necessarily selecting the best producers ".

Owing to the slow rate of reproduction in cattle, the time taken for any programme of cattle breeding is fairly long, and the breeder who is engaged in a crossbreeding project may have to wait many years before any decisive interpretation of results can be made. One can, however, derive some measure of satisfaction by watching the general trend of the results as they start flowing in. It is estimated that at Karagoda-Uyangoda, preliminiary results on production performance should be available for the F_1 Jersey—Sinhala by 1956-57, and thereafter additional information should become available every year.

SUMMARY

It is shown that since characters of economic importance in dairy cattle, such as milk production, are controlled by many gene pairs and have a low heritability, there could be little or no increase in variation in the F_2 compared with the F_1. The conceptions behind the usual warnings never to breed from crossbred animals are contrary to modern ideas on the inheritance of quantitative characters.

The crossbreeding programme that was initiated in 1952 using the Sinhala cattle at Karagoda-Uyangoda as the foundation stock, is also outlined.

The Tuberous Begonia
Its Propagation and Cultivation in Ceylon

BY

G. O. W. RANASINHA

INTRODUCTION

THERE are two types of Begonias in cultivation. One is the fibrous-rooted Begonia which is mainly cultivated for its beautiful leaves and the other the tuberous-rooted Begonia, the cultivation of which is dealt with in this article. Many inquiries have followed the successful cultivation of the latter in the Botanic Gardens, Hakgala.

The tuberous-rooted Begonia, named after M. Michel Begon (1638-1710) has advanced so much during the past 50 years that it bears very little resemblance to the original and now occupies the foremost position in green houses and gardens. It is found in every imaginable shade of Crimson, Scarlet, Rose, Pink, White, Yellow, Orange and Salmon and its lasting qualities as cut flowers make it admirable for sprays, wreaths and bridal bouquets.

The first begonias were singles and the first doubles raised were anything but beautiful. The blooms were small and the petals thin and of a dull red to sickly pink in colour. The plants themselves, were over three feet tall, scraggy, bearing scanty foliage.

All varieties of tuberous Begonias originated from six species, viz., *Begonia boliviensis* collected by Mr. Pearce in Bolivia in 1864 ; *Begonia Pearcei* also collected by him in Bolivia in 1865; *Begonia Veitchi* discovered by the same collector in 1867 near Cuzco in Peru at an elevation of 12,500 ft. ; *Begonia Rosae-flora* imported from the Andes ; *Begonia Davisii* discovered by Mr. Davis near Chupe in Peru in 1876 and *Begonia Clarkii* also from Peru flowered in England in 1867.

Credit for the development of present day tuberous Begonia by hybridisation goes to such veterans as John Laing, Henry Connel, Rev. E. Lascelles and his assistants C. F. Langdon and J. B. Blackmore.

PROPAGATION

The tuberous-rooted Begonia can be propagated by seed as well as by cuttings. Seed is extremely small and very fertile. It has to be sown with great care on a level surface in a mixture of finely sifted leaf-mould and sand and maintained at a steady temperature of 65°F to 70°F until the plants are well established. The young seedlings with three to four leaves should be picked

out into 5 inch pots and subsequently into larger ones taking care not to disturb the root system. The reporting is best done by tipping off the plant from the pot with the ball of earth and transferring it to a bigger pot pressing firmly fresh soil in between the pot and the ball of earth. Plants may be fed occasionally with weak liquid manure obtained either by dissolving nitrate of soda or Sulp. of Amonia 1 oz. to 3 or 4 gallons of water or cow-dung placed in a sack soaked in water overnight. The solution should be diluted to the colour of weak tea and used on a moist soil. This should be done when the plants are about to flower and when flowering.

Propagation by cuttings is mainly confined to rare double varieties and others worthwhile. Stem cuttings may be selected from side shoots towards the base of the main stem. They should be about 4 inches long and removed by two cuts with a very sharp knife one parallel to the main stem and the other parallel to the petiole of the leaf at whose axil the stem shoot is borne. The lowest dormant bud which would remain dormant until the following season and which would be the bud for the next seasons tuber should not be damaged. These cuttings may be potted up singly in 5-inch pots or in pans in a mixture of finely sifted leaf mould and sand and kept at a constant temperature in the shade. These cuttings should not be allowed to wilt lest roof formation be retared. In about 4 weeks the normal cuttings should have rooted but in the case of certain varieties it may take longer. Plants may also be raised by leaf cuttings. The leaf is removed with the heel, i.e., that portion of the stem containing a dormant bud and treated as for cuttings. In 10-14 days they would show signs of growth and a fortnight later they may be potted up into 5-inch pots in the usual mixture.

Certain varieties may also be propagated by spreading the leaf on its back on an even surface of finely sifted leaf-mould and sand and pinned on to the compost by means of wire bent to a shape of hair-pins, the midrib held down by the loop and cut sharp at points where it gives off lateral veins. It will be found that adventitious buds will develop at the first one or two cuts and small rootlets below. The percentage rooting by this method will be found to be very low.

CULTIVATION

The tubers if imported from abroad should be rested for at least 5 days and planted in clean coarse sand in boxes about $\frac{1}{4}''$ below the surface and watered to facilitate sprouting. Care should be taken not to overwater the tubers lest they rot nor allow them to dry up. The young shoots should not be allowed to remain wet. A constant temperature of 55°F to 60°F is maintained.

When the young shoots are about $1\frac{1}{2}$ inches to 2 inches in height the tubers are potted into 10-inch pots in which they are intended to flower in the following mixture :—

4 parts medium loam
3 parts cattle manure (well decayed)
2 parts sand
1 part leaf-mould
$\frac{1}{4}$ part crushed brick to which is added per bushel
5 oz. bone flour
2 oz. old soot
1 oz. sulphate of potash

They are planted firmly at the same depth as in the boxes with a little sand immediately around the tuber and maintained at the same temperature under cover exposed to the morning sun.

Greatest care should be exercised in the administration of water to these plants. Watering should be at the roots preventing any water to come in contact with the young leaves and stems.

Any premature buds appearing at this stage should be picked off. Only one healthy shoot is allowed to develop with two other lateral branches arising from the base of the main shoot of the tuber and when they are about 12″ in height the pots are placed in the Glass House at a temperature of 70°F. Weak liquid manure is given once a week from this stage onwards and the plant staked.

Care should be exercised in tying the plants to the stakes especially when in flower. A little cotton wool is placed where the string comes in contact with the tender stems. As far as possible damage to flowers, leaves and stems should be avoided in the process of tying up the flowers.

The plants remain in flower for about 3 months each flower lasting 3-4 weeks. The largest flower was about 8″ in diameter.

After flowering, water should be gradually reduced and the stems and leaves allowed to dry and fall away. The tubers are finally removed from the pots carefully dried and rested until required.

The following varieties have been successfully cultivated in the Botanic Gardens, Hakgala. Of these the first twelve have gained awards of merit at the Royal Horticultural Shows in London.

1. Rhapsody—Dark pink and pale rose
2. Pamela Simpson—Yellow
3. Sunray—Light orange
4. T. B. Toop—Dark orange
5. Everest—White
6. Aurora—Light brick red
7. El Alamein—Red
8. Harmony—Light pink
9. Jasmine—Light yellow
10. King George—Dark red
11. Rose pearl—Pink
12. Salmonea—Deep orange
13. Lewis bond—Combination of salmon and apricot
14. Lionel Richardson—Salmon pink
15. Diana Wynyard—Slow starter, white
16. Hercules—Slow starter, salmon scarlet
17. Moon light—Creamy yellow

18. Primrose—Yellow
19. Priscilla Irwin—Salmon apricot
20. R. R. Anderson—Crimson
21. Lucy Dare—Pink
22. W. H. Wigley—Salmon orange
23. Mrs. J. B. Butler—Light salmon colour
24. Mrs. J. R. Mann—Rose pink.

PESTS AND DISEASES

Generally in a Glass House the incidence of damage by insect attack is less than in the open. This is due to greater cleanliness and higher temperature. Thrips are known to damage the plants by sucking sap from leaves and stems and they may be controlled by spraying with the following nicotine wash :

$\frac{3}{4}$ oz. Nicotine
1 lb. Soft soap
10 gallons water

Add the Nicotine after dissolving the soap stirring all the time.

Plants are sometimes liable to a leaf curl and in consequence are very slow in growth. This is due to a virus and the only remedy is to isolate and destroy the plants affected.

CONCLUSION

The propagation and cultivation of the tuberous-rooted Begonia can be undertaken profitably in Ceylon especially towards Up-country from a point of view of supplying cut flowers to the local market not only on account of rarity but also of the lasting qualities of the flower.

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Fig. 3.—Another view of Begonias.

Fig. 1.—Tuberous rooted Begonias in the glass-house, Hakgala.

Fig. 2.—One flower of Begonia Rhapsody showing size.

SELECTED ARTICLES

Advisory Service to Help Farmers

BY

W. B. MERCER

ALTHOUGH the use made of land in Britain is, in the first place, a matter for the individual farmer since his livelihood depends on it, it is also a matter of vital concern to the nation, since national well-being requires a high output from the land.

The main current of food production comes, of course, from the farms, and the manner in which the land is used varies greatly in different parts of Britain. On the eastern side where rainfall averages only 18 or 20 inches annually, much of the land is used for growing corn, potatoes, sugar beet and other crops used directly for human food; in the west where the climate is wetter it is used mainly for cattle and sheep.

Taking Britain as a whole, about a quarter is used to produce human food crops; on the remainder, crops for animal food are grown. An intricate pattern of farming has then to be worked out in order to use every field to best advantage, and to ensure a good " fit " between fodder and stock. Moreover, it has long been a tradition that farms shall be managed in such a way as to ensure that soil fertility is well maintained.

In practise this means that a soundly conceived rotation of crops must be followed. Generally this is based on a succession of corn—root crop—grass, the corn being an extractive crop, the root crop serving as a cleaning crop, the grass acting as a restorer of fertility.

USING EVERY AID

A densely crowded island, Britain must grow more food to secure a satisfactory diet, and to balance the national budget. Full use of land means using every aid that science can give. In every county executive committees of farmers have been set up to watch over the general standard of farming. Their members visit all farms periodically. Working in close association with them are the members of the National Agricultural Advisory Service.

This Service, organized by the Ministry of Agriculture and Fisheries, consists broadly of three sections devoted to experimental work, specialized scientific work, and field work. The farms are distributed on soils of different type throughout the country ; they are thus able to test the effect of fertilizers, the value of new strains of crops, the behaviour of farm animals,

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under conditions representative of those obtaining on all types of farms. They can interpret research work in terms of local conditions and provide farmers with a stream of information bearing on their local problems.

The field officers provide the direct contact of science with the farmer. It is their business to organize local technical lectures, demonstrations, visits to experimental and noteworthy commercial farms. Above all it is their function to visit farmers on request to discuss any matter that may arise in the year's round. The simplest of these matters are likely to concern soil management, fertilizers and growth of crops. Now and again the question that arises could better be described as crop hygiene, since it concerns a new method of coping with weeds, a way of protecting a crop against insect or fungus attack, or a method of forestalling a parasite.

More complex are questions of animal breeding, selection of sires of high potency, methods of getting a full return out of grazing land, design of winter rations for stock. Still more complex are the broad problems of farm management—what proportion of the farm ought to be ploughed up, what rotation of crops will best fulfil the needs of the stock, what type of stock is best suited to the farm in question.

THE SPECIALIST

But no one man can be expected to give first class opinions on such a range of questions. The position of the field officer is very similar to that of the family doctor in medicine—he needs from time to time the help of a specialist. The advisory service provides that help through their specialist officers. At eight centres in Britain, local headquarters have been set up, staffed with experienced soil and nutrition chemists, plant pathologists, entomologists, specialists in machinery, animal breeding, milk production, grassland management.

Any field officer, therefore, who encounters problems outside his range, or who foresees complications in any problem on which he has been asked to advise, calls to his aid the appropriate specialist from his local headquarters. The simplest and most obvious case is that of the officer called to advise on fertilizer treatment of a soil about which little is known : the soil chemist by sampling and analysis can provide information which no experience or native genius can rival. Equally the field officer in presence of a disease difficult of identification finds the plant pathologist an invaluable colleague ; and the nutrition chemist can talk in language of certainty on the composition of foodstuffs which he has analysed.

Agriculture in Britain, under the stimulus of national need, surges forward steadily. Its output has risen by over *40 per cent. in ten years.* It is still rising. No rational person would contend that this is wholly due to extraneous aids. Much of it is due to the initiative of farmers themselves ; but certainly one of the contributory factors is the assistance given to them through the executive committees and the National Agricultural Advisory Service.

DEPARTMENTAL NOTES

A Virus Disease of Cacao in Ceylon

BY

J. W. L. PEIRIS

IN recent years considerable anxiety has been felt regarding the future of the Cacao industry in West Africa particularly in the Gold Coast. In the early stages the death of trees which were found to occur in ever increasing numbers was put down to " dieback " and physiological troubles due to excessive removal of shade, excess of soil,moisture, &c. The amelioration of these causes however, did not reduce the death rate of trees as would have been expected if these were the only contributory causes to the dieback. Subsequently however Posnette, one of the scientific officers of the newly opened Cacao Research Station at Tafo established that the cause is a virus disease which has now come to be known as the " swollen shoot " disease of cacao. Later researches showed that several strains of virus are responsible and that the disease is spread by certain species of mearly-bugs from diseased to healthy plants and that certain species of indigenous forest trees can serve as alternate hosts.

At the time when this disease was first recognized in 1939 trees were dying at the rate of one million a year. For the period 1939 to 1945 the annual rate was five million and between 1945 to 1948 fifteen million a year. If it is as estimated, that 50 million out of the total of 400 million cacao trees were infected, this alarming rate of spread is a matter of grave concern to the world cacao market, nearly half of whose requirements are supplied by the West African cacao.

In November 1943 leaf symptoms resembling those of swollen shoot were first noticed in Trinidad in several fields of cacao varying in age from 5 to 15 years. The symptoms resembles those of certain strains of the West African swollen shoot disease complex which do not cause swellings. The Trinidad strains were also not so virulent as some of the virulent strains recorded in the Gold Coast.

Up to late 1949 no virus disease of cacao was known in Ceylon. With the greater publicity attached to the newly discovered disease which was threatening the cacao industry in other countries a close examination of our cacao was begun, starting with the Government Cacao Estate at Kundasale. Early in the course of this survey, leaves of certain trees were found to be bearing peculiar vein clearings and markings which were suspiciously similar to certain symptoms associated with the virus diseases reported from West Africa and Trinidad. The symptoms were present on a considerable

number of trees although most of them had only very few affected leaves. No swellings which are characteristic of certain virulent strains of the swollen shoot virus disease of West Africa have been observed.

There are a number of strains of virus associated with the swollen shoot virus complex. Some of them show very virulent symptoms and swelling of shoots and almost invariably lead to the death of the trees. Others are comparatively mild in their effects and even after four years infection the yield or vigour of the trees does not appear to be reduced. Others strains have intermediate effects. The *local virus is considered to be one of these milder strains* as a virulent strain would have postulated a very much higher mortality than is evident in Ceylon cacao. Specimens of affected leaves were examined by Posnette, the Cacao Virus Specialist of the Gold Coast Research Station and his view is that our specimens show " definite virus symptoms of the veinbanding type similar to those of the milder strains of the virus 1A complex ". The virus on our cacao is very similar to if not identical with that in Trinidad. It will be noted that Trinidad too has comparatively mild strains of the virus. As it is possible that our original cacao came from the West Indies as living plants, the virus too could have come from Trinidad at the time.

It must be realised however, that so far, the diagnosis of the Ceylon cacao virus has only been made on symptom analogy with those occurring in other countries. The diagnosis would be scientifically valid only after the virus has been experimentally transmitted from diseased to healthy plants. Work in this direction is going on and it will be a few months before final results are known.

Now that it may be presumed that a strain of cacao virus is present in Ceylon, it would be helpful to cacao growers to carry a mental picture of the symptoms of the swollen shoot virus disease. The following is a description of symptoms as it obtains in the Gold Coast and points of similarity with the symptoms of the Ceylon virus are emphasised.

LEAF SYMPTOMS

Vein clearing is characteristic of the leaf symptoms. The chlorophyll or the green pigment fails to develop along the sides of the veins and to a varying distance from them. Characteristic patterns clearly seen when leaves are held against the light are thereby formed on them. These patterns may be only confined to transparent streaks scattered irregularly on the veins of the third or lower order only or often the primary and secondary veins are also " cleared " forming a pattern described as the " feather " stage (see Figs. 1, 2 & 3).

In addition to the above certain other features not observed in Ceylon cacao are characteristic of the more virulent strains of virus reported from West Africa. With the latter strains a bulging upwards of leaf areas between the main veins and the decrease in size of the leaves which may look unhealthy and dwindle progressively, have also been reported. It is a

characteristic with mild virus strains on cacao like that observed on Ceylon cacao, that a few leaves with vein clearing symptoms may be followed by subsequent flushes whose leaves are quite normal in appearance. The vein clearing symptoms of Ceylon cacao are present on trees that look otherwise perfectly healthy and with large well formed leaves.

It may be well here to add a word about another type of symptom which may be mistaken for a mosaic caused by a virus. This chlorosis as present investigations show is caused by a nutrient deficiency and will be treated in a subsequent article. In this deficiency chlorosis the cleared areas are between the fine veins and the veins themselves are not cleared as in virus affected leaves. The leaves are also distorted, narrower than normal especially at the base, twisted to one side and hence the name " sickle leaf " is applied to this condition.

POD SYMPTOMS

Our attention has also been drawn to rounded pods occurring on some of the affected trees by Dr. Walter Carter. However, this symptom did not appear to be consistently associated with all the affected trees showing leaf symptoms nor on all the pods of a single tree.

STEM SYMPTOMS

No typical symptoms on the stem has been observed in Ceylon. Swellings of the stem have been reported to be produced by the more virulent strains of the virus in West Africa. However, these and the other symptoms on the stem like short internodes, delayed flushing, etc., could also be caused by insect attack. With virulent strains, dieback is a common symptom even when the environment is good and insects are absent. In Ceylon one has also to take into account the other factors that cause dieback as attack by Helopeltis, deficiency chlorosis, unfavourable water relations, etc.

ROOT SYMPTOMS

Certain strains of the virus are known to produce swellings on the tap roots of seedlings or on the main laterals of the older trees. In the few cases where roots of affected plants were examined here no swellings have been observed.

The various symptoms described above are not of equal value in the diagnosis because some of these symptoms could be due to other factors than the virus. The leaf mosaic is the most reliable symptom provided it is not confused with deficiency chlorosis.

VECTORS AND ALTERNATE HOSTS

These viruses are carried from diseased to healthy cacao by insects which normally infect cacao plants. *Pseudococcus citri*, *P. njalensis* and *P. virgatus* are so far known to be vectors of one or other of these viruses and of these

Pseudococcus citri and *Ferrisia virgata* are recorded on cacao in Ceylon. A number of alternate hosts for the viruses of cacao has been recorded from West Africa. *Chola chlamydantha*, *C. cordifolia*, *C. togoensis*, *Sterculia rhinopetala*, *S. tragacantha* of the family *Sterculiaceae* and *Adansonia digitata*, *Ceiba pentandra* and *Bombax buonopozense* of the family *Bombacaceae*. None of these have been so far suspected to be alternate hosts in Ceylon but a number of dadap trees *Erythrina lithosperma* (*Leguminosae*) were observed at Kundasale to suffer from a virus-like symptom of the vein-flecking type similar to those on cacao (Fig. 4). This could probably be an alternate host of the Ceylon cacao virus but it has not yet been definitely proved.

CONTROL

Control recommendations will depend on the following information that is being presently sought:—

(1) Technical proof of the virus nature of the disease and the specific insect vectors involved.

(2) Evidence on its rate of spread.

(3) Evidence on its effects on yield.

Until more complete information is available it is not possible to formulate specific control measures. It is recommended tentatively that no cacao material except in the form of seeds be taken from areas known to be infected and no new nurseries be raised less than at least 100 yards from infected cacao areas. In the meanwhile any information regarding the presence of virus symptoms of cacao, extent of the dispersion of the virus in individual cacao estates, etc., will considerably help the work of the division of Plant Pathology of the Department of Agriculture.

ACKNOWLEDGMENT

My thanks are due to Dr. Walter Carter for his helpful suggestions in the preparation of this note.

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Fig. 1.—Portion of leaf showing vein clearing in the form of transparent streaks on Ceylon cacao.
Fig. 2 and Fig. 3.—Vein clearing showing " Feather " stage in Ceylon cacao.
Fig. 4.—Vein clearing on dadap leaf (*Erythrina lithosperma*).

Inhibition of Sucker Growth in Tobacco

BY

W. M. WIJERATNE

ACCORDING to general practice most types of tobacco have to be " topped " at the time flower heads appear after the plants have reached full maturity. The operation of topping is the removal of the terminal bud, and this is done just as the flower heads appear.

Topping is done for the purpose of conserving the food supply of the plant in the leaves to produce a crop of good bodied leaf. If the flower heads are not removed, there is the tendency to allow the food material to be dissipated in forming a large head of seed capsules at the expense of leaf which invariably will be thin and papery and of poor quality according to commercial standards.

The primary aim of the tobacco grower is to obtain the maximum possible weight of high quality leaf from the plant. Thus, all his energies will be concentrated on achieving this objective. For this reason " topping " is an essential operation in the case of cigarette, cigar, chewing and beedi varieties of tobacco. The only exceptions are where flower heads are allowed to develop for seed collection purposes and when it is observed in cigarette tobacco that the leaves have grown rank and coarse due to the occurrence of extra nitrogenous fertilizers in the soil. In all other cases topping has to be resorted to in order to produce a leaf of desirable quality.

When this operation of removing the terminal bud is done it is a natural phenomenon to experience a vigorous out crop of " suckers " in the axils of the leaves. If these rudimentary shoots are allowed to grow freely, there will be a negation of the benefits of topping. Hence, the tobacco grower has compulsorily to remove these shoots from time to time as they appear to divert the food supplies of the plant required for leaf development.

Experience has shown that sums varying from Rs. 5 to Rs. 20 per acre have been incurred by growers in Ceylon in removing these suckers. This is a problem that has confronted tobacco growers in all parts of the world.

Investigations have therefore been made to evolve methods of reducing this high cost of suckering. Studies have been conducted with various proprietary preparations containing hormones as well as with vegetable oils.

Hormones applied to the terminal after the removal of the flower bud has shown considerable effects on reduction of sucker growth. In 1947 Anderson in North Carolina (1) successfully inhibited sucker development

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with applications of 5 per cent. of alpha-naphthalene acetic acid. The formation of auxins at the terminal contributed to the inhibition of sucker growth. A fair response has been experienced in investigations conducted in Ceylon with hormones. In 1947, Mc Evoy (2) experimented in Ottawa with chemicals to reduce sucker growth. The chemicals were applied by two methods : (*a*) the substance was applied to the stem wound after topping, mineral oil being used as a cover, and (*b*) the substance was dusted on the top leaves after topping, infusorial earth or talc being used as a carrier. Four chemical substances were tested (i) Methyl ester of naphthalene acetic acid, (ii) Methyl 2, 4-Dichlorophenoxyacetate, (iii) Indolebutyric acid and (iv) Chlorophenoxyacetic acid.

From the results it was evident that treatments with chemicals (i) & (ii) in particular reduced sucker growth very considerably.

Tests have also been carried out by the writer with chemicals which have hitherto been used for causing dormancy in certain varieties of seed material. These chemicals were used with a carrier of mineral oil and applied to the rudimentary buds immediately after topping. With a 5 per cent. strength it was found that a complete destruction of the suckers could be achieved.

Another test carried out with coconut oil by the writer gave very significant results in inhibiting sucker growth. As this oil is a common household item in every village home, it would be very suitable for adoption by the tobacco growers in Ceylon. Trials conducted with coconut oil in India by Dr. Kadam (3) have also proved very successful.

Immediately after removing the terminal bud a very small quantity of coconut oil is applied to the rudimentary suckers arising in the axils of the top five or six leaves with the aid of a crow's feather or improvised brush. If large suckers have already formed at the time of topping, they should be removed before the oil treatment. Care should be taken not to oversmear as there will be a tendency for the oil to trickle down the stem and leaves during hot weather, leaving dark discolorations.

In the adoption of sucker growth inhibition it is essential for the tobacco grower to do the operation of topping at the optimum height. Low topping, especially in cigarette tobacco, should be avoided as it might lead to the production of coarse leaves. For chewing, cigar and beedi tobacco erroneous low topping will not result in such severe detrimental effects.

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(2) Progress Report, 1935-1948—Central Experimental Farm, Ottawa.

(3) Tobacco Bulletin of Indian Central Tobacco Committee for December, 1952.

Paddy Demonstration Results
Maha 1952-53

Division	No. of Plots	Bushels per acre: Control	Bushels per acre: Treated	Increase per cent.
I. *Transplanting alone*				
Northern	21	38.4	54.8	43
North-Central	3	36.6	55.5	52
Central	—	—	—	—
Sabaragamuwa	48	30.0	43.9	46
Western	23	43.8	61.6	41
Southern	6	20.6	38.2	85
Eastern	28	34.4	43.1	25
Trinco.	6	42.2	66.5	58
II. *Transplanting plus fertiliser*				
Northern	8	42.6	61.8	45
North-Central	17	44.5	61.3	38
Central	34	54.7	64.5	18
Sabaragamuwa	4	34.8	48.9	40
Western	33	41.0	61.2	49
Southern	6	56.6	75.0	33
Eastern	35	36.1	43.0	19
III. *Transplanting plus green manure, compost or cattle manure*				
Northern	6	54.5	84.1	54
North-Central	17	30.4	62.2	105
Central	8	56.3	64.4	14
Western	8	26.6	36.4	37
Southern	22	23.0	31.6	37
Sabaragamuwa	3	33.9	44.8	32
Trinco.	2	38.0	65.0	71
IV. *Harrowing the standing crop*				
Northern	19	37.4	53.6	43
North-Central	17	31.2	40.3	29
Central	14	41.6	48.5	17
Sabaragamuwa	11	25.3	37.8	49
Western	52	27.9	35.9	29
Southern	48	21.8	25.8	18
Eastern	68	39.6	50.4	27
Trinco.	7	39.8	51.7	30
V. *Weeding alone*				
Northern	17	35.1	45.2	29
North-Central	2	23.5	42.7	82
Sabaragamuwa	1	19.6	38.0	94
Western	41	35.0	40.9	17
Southern	15	15.9	19.4	22
Eastern	33	35.6	45.8	29
Trinco.	7	39.4	54.0	37

MEETINGS, &c.

PROCEEDINGS OF THE SECOND MEETING OF THE CENTRAL BOARD OF AGRICULTURE, HELD IN THE BOARD ROOM AT THE ROYAL BOTANIC GARDENS, PERADENIYA, ON FEBRUARY 16, 1953

SENATOR The Hon. Sir Oliver Goonetilleke, K.C.M.G., K.B.E., Minister of Agriculture and Food, presided and the following were present:—

Dr. A. W. R. Joachim, Director of Agriculture (Chairman); Mr. C. A. M. de Silva (Vice-Chairman); Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production; Mr. S. C. Fernando, C.C.S., Deputy Commissioner and Registrar, Co-operative Societies; Mr. S. Pathmanathan, Chairman, Low-country Products Association; Mr. S. Pararajasingham; Mr. R. H. de Mel; Mr. Marcus S. Rockwood; Mr. Thomas Amarasuriya; Mr. A. F. R. Gunawardena; Mr. A. Hensman; Mr. N. M. Abulcassim Marakar; Mr. T. Walloopillai; Senator Barnes Ratwatte; Mr. Sydney Ellawala, J.P.; Mr. S. A. I. Elapata, M.B.E., J.P., U.M.; Mr. U. B. Dedigama; Mr. D. G. Dayaratna, C.C.S., Director, Rural Development; Mr. L. S. B. Perera, C.C.S., Land Commissioner; Mr. Albert Godamune; Mr. W. T. I. Alagaratnam, Director of Irrigation; Mr. M. B. Samarakoon; Mr. N. R. Rajavarothiam, M.P.; Mudaliyar S. Armstrong; Mr. M. Senanayake, M.P.; Mr. T. B. Naranpanawa; Mr. A. D. Paranavithane; Mr. S. L. Bandara Dharmakirti, J.P.; Mr. R. T. Chelliah; Gate Mudaliyar N. Wickremaratne; Mr. S. Sivapalan; Mr. Henry Abeyawickrama, M.P.; Gate Muhandiram Arthur D. S. Jayasinghe; Dr. H. E. Young, Director, Rubber Research Institute; Mr. H. S. Hurst; Mr. Wilmot A. Perera, M.P.; Mr. J. A. de Silva, Conservator of Forests; Mr. B. L. W. Fernando, Commissioner, Development of Marketing; Mr. Gladwin C. H. Kotalawala; Dissawe H. B. Rambukwella, M.P.; Mr. V. G. W. Ratnayake, M.P.; Mr. N. H. Keerthiratne, M.P.; Mr. Anton C. Ponnampalam; Mr. A. N. D. A. Abeysinghe, M.P.; Mr. T. C. Rajaratnam; Mr. S. Vytilingam, M.P.; Mr. L. S. Boys; Mr. A. Perumynar; Mr. K. Kanagaratnam; Mr. S. A. Selvanayagam; Mr. Cuda Banda Nugawela; Mr. C. P. de Silva, M.P.; Mr. Kenneth Morford, C.B.E., and Mr. M. Sivanathan, C.C.S., Assistant Director of Agriculture (Administration), Secretary.

The following officials of the Department were present on invitation:—

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture; Mr. T. M. Z. Mahamooth, Deputy Director, Animal Husbandry; Dr. W. R. C. Paul, Assistant Director (Technical); Dr. M. F. Chandraratne, Chief Research Officer; Mr. S. K. Thuraisingham, Divisional Agricultural Officer, N.D.; Mr. S. Kanagaratnam, Divisional Agricultural Officer, E.D.; Mr. A. L. Johnpulle, Divisional Agricultural Officer, S.D.; Mr. A. V. Richards, Horticultural Officer; Mr. D. J. de Soysa, Divisional Agricultural Officer, U.D.; Mr. E. S. de S. Jayasundera, Divisional Agricultural Officer, N.W.D.; Mr. R. E. Ponniah, Divisional Agricultural Officer, Sabaragamuwa.

The following visitors were also present:—Mr. R. H. Greton of the F.A.O. and Prof. E. A. Hardy, Chief of the F.A.O. Technical Team.

Letters and telegrams regretting inability to attend the meeting were received from the following:—Sir Wilfred de Soysa; Mr. G. K. Newton; Senator Lady Molamure; Mr. E. Muttukumaru; Mr. A. T. Sydney Smith, Director, Tea Research Institute; Mr. W. M.

Cumaraswamy; Mr. A. M. Clement Dias; Mr. V. Rajapakse; Mudaliyar M. M. Ebrahim, M.P.; Mr. S. M. Rasamanickam, M.P.; Mr. K. W. Devanayagam; Mr. U. B. Unamboowe, M.P.; Mr. R. Singleton Salmon, M.P.; and Mr. R. H. Spencer Schrader.

Dr. A. W. R. Joachim, Chairman—" Before we go on to the Agenda, I would like to express our appreciation of the great interest that our Minister is taking in our proceedings here. At the last meeting he did indicate that he would follow our deliberations with the greatest interest and that we should have a full day's discussion on Food Production at the next meeting which he himself would desire to attend. Today we have him here and on behalf of the Board I offer him a very warm welcome. We are also grateful to him for having extended to us once again his hospitality at lunch which is awaiting us this afternoon. "

II—Confirmation of the Minutes of the last Meeting

The minutes of the last meeting of the Central Board of Agriculture were unanimously confirmed.

III—Announcement of Personnel of the Resolutions Committee

The Chairman announced the following personnel who would form the Resolutions Committee:—

1. Director of Agriculture (Chairman).
2. The Land Commissioner.
3. The Director of Food Production.
4. Mr. C. A. M. de Silva.
5. Mr. S. Pathmanathan (L. C. P. A.)
6. Mr. H. S. Hurst (P. A.)
7. Sir James Obeysekera (D. A. C. C.)
8. Mr. Albert Godamune.
9. Gate Mudaliyar N. Wickremaratne. } Minister's nominees.
10. The Deputy Director of Agriculture.
11. The Deputy Director of Animal Husbandry. } In an advisory capacity.

IV—Addresses on Food Production by the Director of Food Production and the Deputy Director of Agriculture

Chairman—" It was thought appropriate to initiate a discussion on Food Production with addresses by the two officers who are primarily concerned with the work of the organization of food production in the Island. They are, the Director of Food Production and the Deputy Director of Agriculture who has been entrusted with the function of co-ordinating the work of food production in the Department. I shall therefore call on the Director of Food Production to kindly address the meeting. "

Mr. Manicka Idaikkadar, Director of Food Production, said that it gave him great pleasure to initiate the discussion on Food Production. He explained that food production could not be done by one Department or a group of Departments of the Government but that it was a national undertaking which had to be undertaken with the co-operation of

every peasant in the country. He stated that it was not a new set up that the Food Production Department had organized but that it had taken over the set up of the Land Development Department in which the Director of Land Development did the work of food production although designated as Director, Land Development. To illustrate his statement he read out extracts from the Administration Report of the Director of Land Development which indicated that the functions were similar to those of the present Food Production Department. The functions enumerated were:—

(*a*) The co-ordination of the activities of all departments connected directly or indirectly with the production of food.

(*b*) The provision of staff to carry out the food production drive in addition to the staff provided by the Department of Agriculture.

(*c*) The grant of necessary funds to Revenue Officers for construction and repairs of minor irrigation works, holding of agricultural competitions, propaganda, payment of subsidies for asweddumisation and issue on loan or free planting materials, seed paddy, &c.

(*d*) The grant of repayable loans at very low rates of interest to C. A. P. & S. Societies and their members for food production work.

(*e*) The adoption of special measures for increasing the production of food such as issue of subsidized manure, mechanisation of various stages of cultivation, bringing new foodstuffs under the Guaranteed Price Scheme, &c.

He said that as a former Permanent Secretary had said the Food Production Department should properly be termed the "initiating and the co-ordinating department." Although the Co-ordinating officer between the two Departments was the Deputy Director of Agriculture, who would speak after him, there was liaison not only between various Government Departments but also between the peasants and the Government which was most vital to the scheme. He explained that the functions of the Agricultural Department were quite distinct from the work of the Food Production Department which was a co-ordinating Department between the Government and the peasants and cultivators. Therefore he emphasised that there should not be a feeling that that Department was in any way competing with the Agricultural Department. He added that as the Minister had mentioned, that Department would be the eyes and the ears of the Ministry of Agriculture and Food and that whenever money was necessary to be utilised for a good purpose, the Food Production Department had been allowed to get additional funds without the usual formalities which Government Departments had to observe.

He further stated that District Agricultural Committees under the Chairmanship of Government Agents or Assistant Government Agents played an important part and that agricultural programmes were proposed by that body and that most of those meetings were attended by officers of the Food Production Department. Besides those, there were two other committees below the D. A. C. level. One was at the D. R. O. level and the other at the Village Headman level. The Committees at D. R. OO. level were attended by Co-operative Inspectors, Irrigation Officers, Village Cultivation Officers and those at Headmen's level by Vel Vidanes, Co-operative Sub-Inspectors, C. A. P. & S. Society Office-bearers, and others. Even some Members of Parliament in the Southern Province had volunteered to serve on the second class of Committee so that the M.P. would not only be serving the District Agricultural Committee but would serve the Committees at D. R. O. level and even at Village Headman level. Those Committees also participated in fixing

targets but the question had arisen as to who should fix the targets which was one similar to " whether the egg or the chick came first. " The District Agricultural Committee should know roughly what percentage of improved methods of cultivation were carried on, what particular aspects of cultivation or improved agricultural or irrigation works had to be done for the district, so that once those programmes of work were planned and approved by that body, they had to disseminate those targets to the various D. R. OO. Committees and likewise from the D. R. OO. Committees to Headmen's Committees. The forming of those committees alone would not serve the problem unless the work of the Committee in the field is supervised. For example the work of the Food Production Officer or Overseer should be supervised by the A. G. A. or D. R. O. on circuit, to make sure that all the work is not paper work. It will be advisable for G. AA. and A. G. AA. if they could spare the time to attend some of the Committees at D. R. O's level and Headmen's level and see for themselves what is happening at these meetings. He said that he was glad to say that particularly in the N. C. P., the G. A. and A. G. A. had found it possible to attend 130 Committees at Headmen's level. He emphasised that that was very essential to bring about the necessary co-ordination between the intermediary and lower levels.

Mr. Idaikkadar in referring to the work of the Food Production Department said that he had read an account of Food Production work in India and that their work was identical to what the Department had done and he said he could assure them that the Department had not got the idea from India. The plans of the Department were worked out and he was glad that the Department was not far from the correct path.

Secondly on the question of increased production of food, he said that although that was a question which was rapidly spoken of at public meetings, he would divide it into two classes, namely extension of paddy acreage and intensification of yield in existing fields. Regarding the first category we have to look at the 6-year plan where it is mentioned that 80,000 acres of paddy land would be developed between 1947 and 53, in addition to the 50,000 acres of high land. That was done by the Ministry of Lands and Land Development. They had a programme of work and it was carried out in a very systematic way. Then there was a scheme of subsidy for new land and in that scheme too, the Food Production Department and the Irrigation Department had to come in for providing irrigation facilities and for the development of small works. As the Hon'ble Minister had rightly pointed out, they could extend the extent under cultivation of each village tank by about 5 to 10 acres, the extent that would be benefited to the whole Island would be in the neighbourhood of a second Gal Oya. For the improvement of Minor Irrigation Works the D. I. had a vote of about Rs. 2½ million. For intensifying the yield of existing fields, Mr. Idaikkadar mentioned of the facilities available for the cultivators. There were the Co-operative Agricultural Production and Sales Societies numbering over 500 covering the whole Island with a membership of approximately 120,000. Although the membership was reasonable, about 120,000, the Hon'ble the Minister felt that all cultivators should come within the C. A. P. and S. Societies. He said that the Department was doing its very best to bring the cultivator in contact with the various schemes of the Department. The purpose of the initiation of a discussion on that subject was because there were men of experience who had assembled at the meeting who would be able to tell if the Department had made mistakes and to correct them and to give new ideas. Referring to the benefits that the peasants derived out of C. A. P. and S. Societies, he said that it was not every one who was benefited. It was a very difficult question and the Registrar of Co-operative Societies was doing his very best towards a membership drive and quite a lot had been done in increasing the membership but there was still a long way to go before they could have all

peasants and cultivators within the C. A. P. and S. Societies. There had been certain difficulties when persons who were not members of the C. A. P. and S. Societies asked for loans for agricultural work or when the loan asked for was beyond the maximum specified in that particular C. A. P. and S. Society to which he belonged. As an example he quoted an instance of a gentleman who had been to Australia and had done poultry work. He had asked for assistance from the Department to open up a farm and had applied for some land and Rs. 15,000. But the maximum loan that could be granted by the C. A. P. and S. Society to which he belonged was Rs. 400. There were similar problems which had to be solved and he brought it up at that meeting so that those present might have useful suggestions to make.

In regard to the cultivation of marshy and salty lands, he was happy to say that Mr. C. P. de Silva was the initiator of that scheme and that much headway had been made especially in places like Muturajawela, Barawa and parts of the Southern Province. When he first went there, it was a three-fold problem, the exclusion of salt water, the question of irrigation and also the question of preventing flood damage. He emphasised that he was happy to say that they were now on the right path and that many thousands of acres which would have been difficult to cultivate and which were salty, could now be cultivated.

In reference to the improved methods of cultivation and the intensive methods which the Department was following in order to get better yields of paddy, he said, that there were five or six standard methods of manuring, weeding, transplanting, pest control, &c., but the actual difficulty was to get them across to the peasant. It was not so much ignorance on the part of the peasant but the peasant was peculiar to adopt himself to those methods and much depended on putting it correctly to the peasant. If that was achieved then the problem of the peasant would be solved. The peasant was not a fool and if he knew that those methods were to his advantage, he would certainly take up to it. Another problem was to sell his produce which had been now solved under the Co-operative Purchase Scheme, and the Ministry Scheme of purchasing anything and everything that was produced. Facilities had also been afforded where peasants had difficulty in irrigating, transplanting and weeding. As regards manuring of fields, a fair amount of work had been done and he was happy to say that roughly 1/8th or 1/9th of the total paddy acreage in Ceylon had been manured with artificial manures during the last season. There were also transplanting and weeding campaigns organised all over the Island at the instance of the Hon. Minister. Referring to the Food Production Chart of the Island which was exhibited in the Board Room, he said that the figure for Matara under weeding was 420 acres for 1952 and that, that had been attained purely on account of the Hon. Minister's weeding campaign. He also stated that under that campaign about 400,000 acres had been weeded. Referring to the Transplanting Campaign he said that much useful work had been done and that during a transplanting activity organised at Mawanella, the Leader of the Moral Rearmament Association had remarked that that was the biggest agricultural campaign he had seen in any part of the world. Agricultural Campaigns had also been organised at Arukwatte, Horana, &c.

Referring to the mechanisation of agriculture, Mr. Idaikkadar said that agricultural machinery had been ordered by the C. A. P. and S. Societies on loans provided by his Department, and that much could be achieved in that direction to offset the difficulties encountered by the shortage of labour. He said that the Hon. Minister had asked some of his officers what the real difficulty was in getting the maximum extent under paddy. The answer was, shortage of labour, shortage of buffaloes and various other reasons. He added

that the Director of Agriculture had mentioned that about 250,000 acres of land in Ceylon was suitable for tractor cultivation and it was with that idea that the Hon. Minister had directly ordered that all C. A. P. and S. Societies should be given funds to purchase tractors. He said that there were only about 100 tractors during the pre Sir Oliver days but now there were about 500 tractors and 250 of them would be owned by C. A. P. and S. Societies. He could not however confidently say that everything was well with the tractors because " it was like asking a baby of 6 months for his moustache ". He felt that unless those difficulties were gone into they could never be solved and if everything was planned before a start was given, it would have been too late by the time the planning was over. Societies had been encouraged to adopt tractor cultivation and he was glad to say that the Eastern Province was doing very well indeed.

Going into the matter of subsidiary food production, Mr. Idaikkadar said that, the two food crops which attracted the attention of the Hon. Minister in general when he took over that Ministry was the question of growing chillies and onions. He stressed the fact that " We spent as much as 40 million rupees on the import of those two ridiculous articles of food." He felt that it was an absolute waste of money when those commodities could be produced in this Island itself. A directive had been issued by the Hon. Minister which was sent out to various District Agricultural Committees that the Island should be made self-sufficient in onions and chillies. He was happy to say that the extent under onions had gone up by about 50 per cent. and the extent under chillies had gone up by about 80 per cent. In Jaffna there was the difficulty of obtaining seed onion at the guaranteed price and when representations were made to the Hon. Minister it did not take him two minutes to arrange for a consignment of 10,000 cwt. of seed onion at a special price. He added that about 20,000 cwt. of onions were distributed in areas where no onions had been cultivated before. Even in regard to chillies he said that planting material had been distributed fairly liberally and he was happy to say that their efforts in that direction would be rewarded. In regard to the efforts taken by the Food Production Department towards increasing high-land cultivation, he said that the general complaint was lack of wells. For construction of wells on Crown land, the Land Commissioner had an allocation to give a subsidy but in case of private wells too there was a similar demand from the people of Jaffna to extend their cultivation, and the Hon. Minister had sanctioned similar facilities. No sooner that subsidy was sanctioned, the people in the north promised the Minister that they would construct 1,000 wells within the current year. He was glad to say that there was no difficulty at all in reaching that target of 1,000 wells, a scheme that originated in Jaffna, and that it would be applicable to the whole Island without any restriction whatever.

He said that the Department had also been handling a scheme of home gardens and a potato drive at Udukinda. He added that about a thousand home gardens had been brought under cultivation mainly due to the efforts of the Divisional Agricultural Officer, Western Division. He remarked he would, however, not say that it was a great success but at least a thousand homes had cultivated home gardens during the last season and hoped to extend that scheme to other places. As regards the Udukinda potato drive, what the Hon. Minister had directed him was to try the " vedarala " system as the Department of Agriculture was not in a position to recommend the cultivation of potatoes on a scientific basis. The " vedarala " system continued and 100 tons of potatoes had been distributed and he was glad that the Assistant Registrar of Co-operative Societies, the Government Agent, Uva, and the Divisional Agricultural Officer had done a remarkable job in making that scheme a success.

In regard to other aids and efforts the Department was making, he said he would like to say that the necessary insecticides and fungicides had been purchased and a staff of 50 persons would do weed control work under the direction of the Department of Agriculture. The Department was also making every effort to keep the peasant informed of what the Government was doing to assist them in food production. Every Wednesday there was a Radio talk in Sinhalese and every fortnight there was a talk in Tamil. From the letters he received it was evident that there were thousands of cultivators who were satisfied with the benefits they derived by those radio talks. Propaganda was also being done by organising talks, issue of pamphlets, &c.

In conclusion Mr. Idaikkadar remarked that he would appeal to everybody present at the meeting for any constructive criticism and everything possible would be done by the Food Production Department to help the peasant cultivator. He emphasised that the Department was prepared to do whatever the Ministry and the people wanted it to do, so that the best results were conveyed to the peasant. He said he would take that opportunity to thank the Co-operative, Agricultural and Marketing Departments for the part they had played in making food production a success.

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture addressed the Board next—"Hon. Minister, Mr. Chairman and Gentlemen—I have prepared a concise statement to be the basis of our discussion this morning. I shall, with your permission, read it to you." The following address was read by him:—

Food Production

The main activities of this Department are directed to food production. The field divisions are entirely engaged in it, while the Research Divisions devote a greater part of their time to investigational work on food crops.

The organisation for food production is as follows:—There are ten Divisional Agricultural Officers in charge of the nine Provinces with an additional officer for the Trincomalee District. These officers are stationed in the Provincial centres. In order to further intensify food production activities ten Senior Agricultural Assistants have been appointed in October, 1952, to ten Revenue Districts which are controlled by A.G.AA. These twenty officers are assisted in food production by 93 Agricultural Instructors, 93 Food Production Officers, 130 Field Demonstrators and 600 Food Production Overseers. With the formation of the new Ministry of Agriculture a co-ordination of all Departments concerned in food production has been brought about as explained by the Director of Food Production. This has been a long-felt need and more effective work is now being done with the minor village officers, such as Village Headmen and Vel Vidanes, coming into the scheme of food production. The planning of details and the final implementing of the food production targets are now carried out by these village groups.

Paddy cultivation has naturally received our chief attention. The total paddy acreage of the Island worked during both seasons does not probably exceed 900,000 acres. It has been said that Ceylon has the lowest yields in the world and the figure of 14 bushels per acre has been quoted. This Department has maintained that this figure is totally incorrect. During the last two years a scientific crop yield survey by methods of crop cuttings has been carried out, and it has shown that the all-Island figure of yields are 30 bushels per acre for *Maha* and 29 bushels per acre for *Yala*. The figures for different districts are much higher ranging up to 45 bushels per acre for Vavuniya and 50 bushels per acre for Trincomalee. I shall now comment briefly on the progress made with the introduction of improved

methods of cultivation. In order to popularise these simple but more efficient methods we commenced a few years ago the plan of demonstrating to the cultivator the benefits of these methods through demonstration plots in his own field. In every large *yaya* throughout the country there are a number of demonstration plots where one or more of these methods are practised. This affords an excellent method of visually demonstrating to the cultivator what can be achieved by these improved practices. For this purpose demonstrations are held at the proper stage, during preliminary cultivation if it is to demonstrate the use of improved implements or transplanting or harrowing the standing crop, and towards harvest time when the benefits of using pureline seed or the application of fertilizers are demonstrated by the crop itself which is contrasted with that on adjoining fields on which these practices have not been adopted. After the harvest handbills are issued with yield increase and with the name of the field and of its owner so that cultivators may know for themselves the facts.

The results of these demonstration plots have recently been published in the Tropical Agriculturist. Yield increases obtained from these practices naturally vary very widely according to soil conditions, the standard of general cultivation and degree of efficiency with which the practices are carried out. Transplanting alone has shown yield increases varying from 14 per cent. to as much as 85 per cent. with an average of about 40 per cent. Transplanting plus fertilizers have given increased yields up to 80 per cent. with an average of about 45 per cent. Harrowing the standing crop has shown increases varying from 23 per cent. up to 55 per cent. Use of green manure or compost or cattle manure in addition to transplanting have shown increased yields ranging from 15 per cent. to 63 per cent. Simple weeding has given increases of 25 per cent. to 40 per cent.

The use of pureline paddy seed has evoked much interest. There are at present twenty-four pureline varieties of paddy available for the Maha season and fourteen varieties for the Yala season. Drier areas of the country are well supplied with suitable pureline varieties but the position in the Wet Zone is rather different. This is due to the fact that in the wet districts a very large number of varieties of varying ages or duration are being sown. This is due to very many reasons including the rapid change of soil conditions within a short range in wet districts. However, the Department is making selections of the popular varieties in each district and this work is well in hand already. Thus we have selections of Sulai, Hondarawala, Rankiriyal and Samba for the Southern and Sabaragamuwa Provinces. At the Mawatagama Paddy Station there are as many as 150 varieties of Hondarawala under trial for selections to suit the Kalutara District. At the Karapincha Station off Ratnapura a number of foreign paddies ranging from $4\frac{3}{4}$ to 6 months duration have proved strikingly superior to local varieties and have already been released for issue as seed to this District. For the Kandy District desired types are Hathiel and Hondarawel and trials with these are progressing at a paddy station at Gampola. Successful varieties for saline areas are also available. We have suffered from the lack of suitable blocks of paddy fields for experimental purposes in the Wet Zone but we hope to acquire the necessary land with the help of our Minister.

Regarding the dissemination of pureline seed we had in the Maha season 1951-52 as much as 105,980 acres under pureline varieties, and in the Yala 1952 there were 50,735 acres, making a total of 156,716 acres under purelines for the two seasons, or about one-sixth of the total area cultivated for the two seasons. This tokens good progress.

The method of production and dissemination of pureline seed in the past has been as follows. Seed raised on departmental farms being limited in quantity is distributed in every district to a number of private seed farmers who multiply the seed and become entitled

to a premium of Re. 1 per bushel for the seed which they make available to other cultivators. This scheme unfortunately fails when the price of paddy exceeds the guaranteed price, at which alone Government can put through the transactions. C. A. P. and S. Societies, which have been expected to purchase and store the seed necessary for their members, have also hesitated to buy seed for the same reasons. Therefore the paddy seed multiplied from the departmental seed has to a very large extent found its way to the trader.

In order to overcome this difficulty we have devised a new scheme in which a number of seed farmers are appointed in every large *yaya* throughout the country. These seed farmers are expected to exchange pureline seed at harvest with their neighbouring cultivators for the latters' ordinary seed. Thus in the first season the seed farmer receives departmental seed. In the next season he distributes the seed multiplied by him to the cultivators giving each a sufficient quantity only, which when multiplied in the third season will cover the whole extent of the paddy fields owned by him. Therefore in the fourth season the whole of the *yaya* will be brought under pureline seed. Although this scheme of exchange may appear very simple there are numerous difficulties even in this scheme. Seed farmers will not accept any and every variety of consumption paddy offered to them by cultivators. Again if a drought interferes the chain of work is broken and the seed becomes useless for the following corresponding season, and shorter age paddies have to be sown for a late crop.

In 1949 the total issue of pureline seed to cultivators from departmental and private seed farm sources was 77,000 bushels ; in 1950 the issues totalled 103,200 bushels ; in 1951 the figure was 138,700 ; in 1952 the total for the two seasons has been 185,900 bushels. In this same year, 1952, 20,000 bushels of seed raised on one of our farms had to be sold for consumption as they were found contaminated by a disease and therefore unfit for seed. It will be appreciated that the seed thus issued is in circulation among cultivators during the subsequent seasons so that the total area under pureline seed is much more than can be deduced from the yearly issues of seed. This explains how today we have nearly one-sixth the total area under pureline, taking both seasons of the year. The extension of pureline seed is therefore progressing very rapidly from year to year.

Transplanting and harrowing the standing crop are two practices which have, during the last few years, been adopted by cultivators on a considerably increasing scale. It should be noted that neither of these practices are possible unless there is sufficient water at the correct time. Weeding is a simple process practised efficiently in parts of the Wet Zone, but neglected in other parts such as the Balangoda district where there is a scarcity of labour. Weeding again cannot be done if the rains fail. I may here mention that in Galle District out of the total 39,400 acres of paddy land 38,100 are only rain fed. Similarly in the Matara District out of a total of 43,490 acres 34,266 are rain fed or unirrigated. It will be appreciated that under these conditions transplanting, harrowing the standing crop and even weeding are seriously interfered with. Transplanting and weeding require labour. In the wet districts plantations draw all the labour and so labour is scarce for paddy work.

Green manuring is another practice which has been encouraged and has become popular. Recently we have borrowed an Indian practice. A species of green manure *Sesbania speciosa* seed are sown along the margins of paddy fields, and when the harvest is over these plants which have meanwhile grown up are cut and applied to the field as green manure. The use of compost and cattle manure has been encouraged. In the N. C. P. there was a cattle manure drive and a large amount of money was paid in the form of savings certificates to cultivators. The use of artificial manures in Ceylon has been chiefly confined to bone meal. Recently this Department has recommended paddy mixtures suitable

for the Dry and Wet Zones. In 1951, the Government introduced a subsidy of 35 per cent. of the cost in order to encourage the use of fertilisers. It is gratifying to state that this subsidy, coupled with the guaranteed price of paddy, have induced cultivators during the last three seasons to use considerably increased quantities of artificial manures. The total issue of artificial manures for Yala 1952 was 1,600 tons and for Maha 1952/53, 2,800 tons, and from the inception of the subsidy 6,000 tons representing 120,000 acres manured.

The use of the light iron plough and the Burmese harrow has been encouraged by demonstrations during many years. In some districts there are today as many of these ploughs as the cultivators will require. A recent census in the North-Western Province showed that over 30,000 of these ploughs are in use. In the Batticaloa District the total number of ploughs is 3,440 ; in the Vavuniya District in 1950 we issued 3,900 iron ploughs and 1,450 Burmese harrows. The figures for 1951 for all Divisions are 4,240 ploughs and 2,670 harrows issued.

In the meantime cultivators in the chief paddy provinces have got accustomed to the use of tractors and tractor implements. There are five Tractor Units under Government control. Private enterprise has also embarked on the purchase of tractors which they also hire out. There are fifteen privately owned tractors in the Jaffna District and the same number in the Batticaloa District. Three hundred tractors are being purchased by the C. A. P. and S. Societies during this year and hundred more are being acquired by the Department of Food Production for the establishment of further tractor units, so that very soon there will be 400 more tractors available for paddy cultivation.

Government has also paid attention to conserving our paddy crops from the damage caused by insect pests and diseases. The cultivator is very slow to spend on insecticides. This has compelled Government to undertake the control of pests and diseases especially where they have appeared on a large scale, and the expenditure during 1952 on this item amounts to about Rs. 80,000.

I may now turn to highland food crops with which I shall deal very briefly. Most of these have been brought under the Guaranteed Price Scheme. In recent years we have made strenuous efforts to popularise Sorghum as a substitute food crop for rice. In 1950 the area under this crop was about 2,100 acres. In 1951 the area rose rapidly to nearly 6,000 acres. Unfortunately very severe bird damage is sustained by this crop and cultivators have got discouraged. The cultivation of onions rose to 3,500 acres in 1951 and reached 7,063 acres in 1952, while that of chillies increased from 10,500 acres in 1950 to 16,860 in 1951, and reached 25,300 acres in 1952. The increased output of chillies was reflected in 1951 in the import figures which decreased by 20,000 cwt. in spite of the increase in population. In October, 1952, under the direction of the present Minister for Agriculture and Food, a very extensive drive to increase the output of onions and chillies was undertaken with a target of 60,000 acres for chillies and 15,000 acres for onions. Very large quantities of chillie seed have been issued free while seed onions have been supplied on a correspondingly large scale at cost price. It is most unfortunate that an unexpected drought has interfered with this excellent effort. Some figures of production of highland crops are seen on the chart exhibited today. Cowpea is another crop which is fast becoming popular. If not for drought conditions our achievements would have been considerably greater.

We have launched drives for the extension of the cultivation of coffee and pepper, vegetable and yam. Two of the wet zone Divisions, Central and Sabaragamuwa alone issued in 1952, 58,700 coffee plants and 78,600 pepper cuttings. Other wet zone Divisions have

also issued several thousands of these plants. The cultivation of potatoes has been extended very considerably in the Nuwara Eliya District, a Potato Growers' Association has been formed and 100 tons of seed potatoes have been imported for them from abroad.

In order to encourage cultivators to adopt improved methods of cultivation, the Field Divisions have carried out a great deal of propaganda. Field days have been organised on a large scale to demonstrate ploughing, transplanting and harrowing the standing crop. A large scale weeding drive was organised last season. Government has spent large sums of money in every Province as prizes for competitions for transplanting, weeding and other improved practices. In several such competitions 800 to 1,000 women and men have taken part. In addition a series of radio-broadcasts have been inaugurated in which cultivators from various districts describe their experience and the benefits they have achieved from the adoption of better methods of cultivation. More attractive and simple agricultural leaflets with illustrations, and more cinema films of local interest are being produced.

Finally, I wish to refer to two important steps taken by Government which have enabled us to achieve progress in food production. The first is the Guaranteed Price Scheme which secures for the cultivator an economic price with a sufficient margin of profit for his produce. The other is the establishment in recent years of Co-operative Agricultural Production and Sales Societies. These Societies are a medium for granting loans to cultivators to enable them to provide themselves with implements, barbed wire, to enable them to meet the cost of transplanting, weeding or other improved practices or to purchase artificial manures, and even to obtain a loan of Rs. 20 per acre to enable them to subsist during the time of cultivation. I cannot help pointing out that in the past the efforts of this Department have been mostly seriously handicapped by the absence of these facilities. When the best advice has been given, it will be fully appreciated, that very little progress can be expected from the cultivator unless and until his economic condition is improved. To increase yields and the production of paddy when prices did not even meet the cost of cultivation was a futile effort. It is the Guaranteed Price Scheme which has solved the major difficulty of an economic price for the cultivators' produce. C. A. P. and S. Societies have enabled the cultivator to escape the clutches of the middlemen and money lenders. Even now the paddy cultivators in many districts are labouring under several difficulties. What incentive have we, they query, to purchase and apply artificial manures when we have to pay for the manure while our landlords take away half the results of our efforts leaving us hardly a small margin of profit to compensate for our labours. The Paddy Bill will undoubtedly solve some of these difficulties ; but there are several problems connected with the *ande* system of cultivation which still have to be adjusted if the cultivator is to be encouraged to adopt improved methods of cultivation.

Stray cattle are another big factor which causes loss to the paddy output of this country. In the N. C. D. as much as 30 per cent. of the crops are lost through stray cattle. In the Galle and Matara Districts cultivators say that unless the stray cattle nuisance is controlled they are not willing to invest on artificial manures or to incur the cost of other improved methods. Altogether, whilst there is room for this Board to suggest to us directions in which we can still increase and improve our efforts for increased food production, I once more stress that the pivotal problem is the economic one, and that whatever success has been achieved in the last few years has been in very large measure due to the steps taken by Government to solve these economic factors.

At the conclusion of the address, the Chairman stated—" Gentlemen, we have heard two interesting addresses by Mr. Idaikkadar and Mr. de Mel. These addresses survey the position in regard to what Government is endeavouring to do to solve the problem of food production. Now that you have had the official viewpoint, I think we shall be glad to hear the views of the many members present here, on this important subject. I would be grateful if members could be brief, particularly as there are several members who would like to speak."

Mudaliyar S. Armstrong speaking first said he came from Batticaloa where there was plenty of paddy cultivation and hoped members would listen to the points he raised.

First he said he would mention that there were about 23 Irrigation schemes in the Batticaloa District but the channels leading from such schemes were not sufficiently opened up by the Irrigation Department, and that some of the existing channels should be modernised and systematically regulated if 55 to 60,000 acres served by them improve their yields. He emphasised that that was not the fault of the Irrigation Department but he was aware that the Irrigation Department did not have the funds for such work. He said he was not asking for the restoration or construction of new tanks but he was only requesting that the conditions of the existing tanks and channels should be improved for the benefit of the people who owned land and who could meet the demands of the country to some extent. He added that under such a defective system of irrigation it was not possible to do transplanting. To quote an instance he said that 150 acres of his land was prepared for a demonstration and that it took three weeks for the Irrigation Department to make the water available and even the water made available was insufficient and it had to be pushed on through other fields. As a result of that delay the officers who were summoned for the demonstration had gone away.

Another defect he would like to point out was that most of the fields were not levelled so that there was no easily flow of water from one field to the other and as a result transplanting became a failure. He said that there were about 60,000 acres under major schemes but the fields were not levelled. He felt that the Director of Agriculture would agree that levelling had a great deal to do with successful paddy cultivation. As the land was sloping the possibility was there for the water to hold up in one place and certain other places not to have sufficient water. The consequence was a poor yield. He therefore suggested that levelling should be undertaken by means of Caterpillar tractors and emphasised that it was not for the C. A. P. and S. Societies to undertake such work but it was for the Agricultural Department. He felt that the rubber tyred wheeled tractors purchased by C. A. P. & S. Societies were not suitable for moving earth, &c., but were meant for small jobs and not for big acreages. Mudaliyar Armstrong also remarked that as a result of the Hon. Minister's colonisation schemes in that area, there was a shortage of labour and owners of land had to give some of it to others for cultivation.

At this stage a member remarked that that seemed to be a good policy—(Laughter),

Mudaliyar Armstrong continued that human as they were, they would always like to have more and more land. He suggested that the only solution to the shortage of labour was the introduction of mechanised agriculture and made special mention of mechanised methods of harvesting. He had seen some harvesting machines at work in the Gal Oya Board and felt that about 40 per cent. of the produce went waste as the paddies grown in

the Island were lodged thus rendering machine harvesting difficult. He urged the Department of Agriculture to find out a variety of " stiff-strawed " paddy which would stand mechanised harvesting.

Referring to a statement by the Director of Food Production that steps were being taken to control pests and diseases by means of insecticides, Mudaliyar Armstrong said that just as in the case of the D. D. T. Spraying Unit of the Medical Department, it was essential to have separate staff for spraying insecticides because the Agricultural Instructor would not be able to handle the situation without additional staff for that purpose. As an alternative he suggested that the services of Village Cultivation Officers could be utilised with the necessary labour provided to them for the purpose.

Another difficulty Mudaliyar Armstrong had experienced in his area was the shortage of storing facilities for paddy. He emphasised that the result was that owners of paddy had to dispose of it at low rates in order to make room for the next crop. He believed that Government was taking action in regard to that matter and requested that action be expedited on account of the present crisis. He added that he would like to remind the House that the present system of Village Cultivation Officers was initiated by Government after a motion introduced by him at the Board of Agriculture in 1935 and he was glad that they were doing useful work. He said that Village Cultivation Officers were at present supervised by Government Agents who had multifarious duties and in some instances they had delegated that function of supervising the V. C. OO. to Divisional Revenue Officers. He felt that even D. R. OO. would not be able to do that function properly as they too had various other work which occupied them fully. He requested that his suggestion that Village Cultivation Officers be supervised by the Director of Agriculture should receive the consideration of the Chairman.

Mudaliyar Armstrong said that he understood that the manure issued to farmers was subsidised to the extent of 33 per cent. Even though they obtained loans from C. A. P. and S. Societies to purchase manure, they were not in a position to spend on manure and begged that the Government should consider increasing that subsidy to 50 per cent.

The other point he would like to bring up at that meeting was the unsatisfactory state of the plough produced by the Government Factory. He had had the occasion to point out to the Divisional Agricultural Officer that the ploughs sent by the Government Factory were of no use. The plough shears were of an inferior steel so that they wasted quickly and the farmer had to incur heavy expenditure on replacements. He emphasised that the Factory Engineer should be instructed to press the steel and turn out shears so that the ploughs turned out by the Factory would be of a better quality.

The next point he would like to comment was on the necessity of putting up flood bunds. In Batticaloa there were a number of fields adjoining lakes which required flood bunds, and urged that Government should take early action on the matter.

In conclusion he said that it was his view that at a time when the country was doing everything possible to step up food production to its maximum, the introduction of the Paddy Bill would not be feasible because as it had been mentioned that a lot of changes would take place with more experience, ultimately the whole Bill would have to be amended.

Professor E. A. Hardy, Leader of the F. A. O. Technical Team stated that he had been asked to say a word or two about the paddy harvesting machinery at Hingurakgoda at the present time. He added that last year due to the enormous amount of paddy which was particularly difficult to handle, they had rtalised the need for some carefully worked

out mechanisation. He also mentioned about a rotary mower that he had seen when he was last in Australia which might be suitable. He said that Dr. Chandraratne had developed a stiff strain paddy which he understood was being grown at Hingurakgoda and that he hoped to try the combined harvester on that variety during the next season. He added that they were co-operating with an F. A. O. machinery man who would work on the requirements of Hingurakgoda and try out all the possible ways of cutting paddy and the use of machines as well as hand harvesters and also the use of threshing machines and winnowers. He mentioned that there was an F. A. O. man due in the Island in a day whose main job was to design and work out simple tools required by farmers for their cultivation.

In regard to the other point about levelling equipment for fields, he said that the present machinery pools had a number of tractors with bull dozers and levelling equipment and that in future machinery pools would have equipment which could be used for a more scientific job of levelling and more effective irrigation throughout the country.

Mr. Albert Godamune speaking next said that while listening to the Deputy Director of Agriculture and the Director of Food Production, the impression created in that House was that such a large amount of work was being done towards food production and that the scheme suggested appeared to be so well thought out and so carefully planned that they would bring the country to the required goal. He said he lived in a village not far from Peradeniya where he worked his own paddy fields, and that he owned some paddy in the upper reaches of the Uva Province and also in the North-Western Province. He cautioned the House that all their efforts concentrated towards paddy production and food production were almost absent in the villages, " because there is something missing between what we are doing here and the man who is actually at the job. " He felt that the village population had not still realised the emergency whereas the rest of the population who read newspapers, &c., were aware that the food production question of the Island was a very serious one and that considering what was happening in the rest of the world, the situation in the Island might amount to a crisis. Under such circumstances, unless some means was found of creating more enthusiasm among the peasant population to bring home to them the state of the emergency and the anxiety that the country was facing, the goal that the Government was hoping to reach might take longer than expected. He observed that a great deal of concentration has been placed on the centralisation of the activities of Government. He added that it was perhaps a necessity under the old Colonial form of Government, but centralisation had removed consciously or unconsciously the initiative of the man at the bottom. Even the present efforts of the Government to tackle the present problem would not reach the level of the masses and the peasant, if the activities were centralised in one Department. He stressed the importance of the immediate need to make the masses feel what their job was also in the Government's efforts in that direction. He emphasised that they should be made put their shoulders to the wheel and feel the responsibility just as much as anybody else and try to avoid a crisis. Therefore he suggested that the various District Agricultural Committees and Associations at D. R. O. level and various levels should be reorganised from the bottom and not from the top, as they were now. He felt that it would be more useful to summon mass meetings in villages, talk to them on agriculture and various other problems and tell them of the immediate necessity for increased food production. It was essential to get them also to join in and invite suggestions and give them also a share of the responsibility. He said that according to the Mahavamsa, the country had concentrated on the cultivation of two kinds of grains, namely, paddy and

kurakkan. Two methods had been devised for the cultivation of paddy, one for the dry zone and the other for the wet zone. Cultivation in the dry zone entirely depended on an adequate conservation of water, but a system of conservation of water in tanks and ponds of both zones had existed, and a great deal of importance had been paid to that work. It must be realised that conservation of water was as necessary in the wet zone as in the dry. Even Robert Knox's book on Ceylon gave a full description of the methods adopted for the conservation of water in the wet zone which is vital to the paddy plant at various stages of its growth. Storage and irrigation was so arranged even in the wet zone that water could be diverted into the beds and out of them when it was so necessary, and sowing should be independent of the vagaries of the weather. There were storage tanks not only in the dry zone but also in the wet zones. At that time there were vast tracks of paddy and at the head of each field was a pond or a " pathaha " but today none of those are in existence. At the time of the conquest of this Island by foreigners, the first step taken by the Military was to destroy all irrigation works and tanks. He quoted extracts from reports made by various Military Officials at the time in the memorandum he had submitted to the Central Board. In one instance a Governor had written that the destruction had been so complete that cultivation had ceased altogether. In 1818 the Commandant of the British forces had written to the Government that the rice production in the North-Western Province was so great that an export trade should be started. Not only in the North-Western Province but also in the other Kandyan provinces there was enormous rice production and there is nobody who could tell at the present moment what had become of those rice fields.

He emphasised that in 1941 a Commission was appointed to go into the question of paddy production in the Island. There were about twenty committees appointed to report on suitable measures for the improvement of paddy cultivation. All those committees had recommended the restoration of little irrigation works which was so vital in that direction. He regretted that hardly anything recommended in those reports had been carried out. Even the Kandyan Peasantry Commission report issued about two years ago had recommended about three or four thousand small irrigation works. The cost of that work had been estimated at 9 million rupees, and the area that would be brought under cultivation was about 100,000 acres. If for 9 million rupees that extent could be brought under cultivation, he believed that it would be more than what the country had been able to do during the last 20 years. He said that even large schemes like Minneriya, Gal Oya and Minipe had not irrigated that extent. The items of work recommended were ranging from Rs. 1,000 upwards and the biggest job would not amount to anything over Rs. 50,000. Mr. Godamune also stated that although the Deputy Director of Agriculture had mentioned in his address the steps taken to induce cultivators to transplant their paddy, there was considerable difficulty in getting the water at the proper time. If by any chance the transplanting was delayed due to the inadequacy of water, the yield was reduced by about 50 per cent. He said that it was therefore best to concentrate on one essential point to meet the emergency and not to concentrate too much on major schemes which took several years to complete and cost the country such heavy expenditure. He said he could assure the authorities concerned that if more attention was paid to minor irrigation works, the output of paddy could be doubled or even trebled. He added that the peasantry of the Island were not ignorant of agricultural practices but they should be afforded the proper facilities. He also advocated the practice of cultivating kurakkan where rice cultivation was not possible, instead of concentrating on other grains. He said that the peasant knew how to grow kurakkan and he knew the value of

it. If their system of growing kurakkan on chenas was considered by the Department to be wasteful, the solution was to give them an alternative method of cultivation, just as in Jaffna where a new method of growing kurakkan had been initiated.

Mr. Sivapalan said that he agreed with the previous speaker that the peasant should be given an exact idea of the country's difficulties and the various problems. He said he was sorry that the peasants in the colony in his area were becoming irresponsible and lazy. The present national emergency required a mass movement in addition to what the several Departments were doing in the cause of food production. He felt that there should be an organization to create the necessary incentive in the peasant and make him feel his responsibility to undertake the national task of food production. The peasant felt that the country could afford to go on spending at the present rate on the various schemes and subsidies but they did not realise the state of the emergency and that it was their responsibility to deliver the goods.

The other point he would like to stress was that the Deputy Director had given some figures on the chart against Trincomalee which in his opinion required scrutiny and requested him to examine the statistics more carefully. He was aware that Trincomalee produced a record number of bushels per acre and even the extents covered under transplanting and weeding were, in his opinion inaccurate. He therefore requested that those statistics be examined more carefully and that those figures be reconciled.

Mr. Marcus S. Rockwood emphasised the necessity of restoring tanks in the Puttalam District and Kurunegala District which ranged from extents of 50 to 100 acres. He remarked that it was useless settling people on land where there was no water. Commenting on the address of the Director of Food Production that a thousand wells had been constructed in 1952, he inquired whether a survey had been made to find out how many of those wells were being used. He emphatically reiterated that 50 to 60 per cent. of the wells constructed in the Puttalam area and the North-Western Province at a cost of nearly two or three thousand rupees were abandoned because either the water was brackish or the wells were dry. He added that it was a sinful waste of money to have constructed those wells without realising the amount or the quality of the water that would be available. Consequently any of the wells sunk in the Puttalam District could not be used.

The next point he would like to bring forward was in relation to acreage under pureline paddies. The address of the Deputy Director of Agriculture revealed that 185,000 bushels of pureline seed were issued to cultivators. He inquired what that represented in terms of acreage, the sowing extent and how much paddy was harvested from it. It was his experience at District Agricultural Committee meetings that Divisional Agricultural Officers produced sheets of paper giving targets and how much of seed paddy was issued but the actual extents cultivated were absent. He deplored the present practice of all talk and no work. He remarked that what the farmer needed was sufficient water and he would produce more and more. He said that when the Hon. Minister was in Puttalam he had suggested that a survey of all the small tanks should be made for the purpose of restoring them. He agreed that that was a step in the right direction. He hoped that the Hon. Minister had obtained the necessary information he required and that action would be taken in that direction, so that by next Maha all the tanks that were idle could be used for extending cultivation. He also observed that better co-ordination in production and marketing would be a further inducement to the cultivator.

Mr. Wilmot A. Perera, M.P., said that the difficulty of restoring minor irrigation works was not due to lack of funds for such work and it was his experience that some departments could not expend the money that was voted due to lack of personnel, &c., and ultimately the provision lapsed. He said that action being delayed on minor irrigation works for several years was a great hindrance to cultivators. He emphasised that more paddy could be produced if more attention was paid to minor irrigation works than major irrigation schemes.

He stated that there was another point he would like to raise in all sincerity and that was the detaching of coupons from the ration books of cultivators. He added that in his area cultivators were all up in arms against that practice which was a hindrance to the cultivator whereas at the present moment every incentive should be given to cultivators to increase their production. He appealed that that was a matter which should be gone into. Mr. A. F. R. Gunawardena was also strongly opposed to the present practice of detaching coupons from ration books of cultivators. He said that it undermined their ability and incentive to work their paddy fields. He pointed out that the yield from a paddy field could not be fixed as it was liable to vary with weather conditions and various other factors. He added that it was not only the coupons of the cultivator which were detached, but his whole household was deprived of coupons. For an example he quoted his own case when he and his whole household had been deprived of coupons. He had made representations on this matter and the answer was that that question would be considered before the next issue.

The next point he would like to touch upon was, that from the two earlier addresses on food production it seemed as if the whole country had entrusted the matter of food production to the peasant. He said he would rather like the peasant to put his shoulder to the wheel and help the country in the task of food production but he would not encourage the peasant being " spoon-fed " by Government at every turn. The result was that the initiative of the peasant was lost and his mentality was to look to Government for all his needs. He emphasised that he was not in the least against the peasant being helped to that extent by Government but his point was that the peasant should not be made to depend entirely on the Government. He pointed out that an extent of 100,000 acres was allotted to the peasantry for growing budded rubber with a large staff of Inspectors and Conductors paid by Government. Some of the Conductors did not even know the difference betwten budded rubber and ordinary rubber. Today the result was that 85 per cent. of that land was bare and lying waste. If that land had been owned by people who could have worked it, today there would have been an additional 5,000 tons of manufactured rubber added to the quota. He said that that was another instance of the peasantry being spoon-fed by Government.

Going into the question of Food Production on estates and the position of the planter, he said that everybody would be aware of the legislation that was introduced by Government making it compulsory for estate owners to grow food under rubber trees, between tea bushes and under coconut trees. It took years for Government to realize that they had started the impossible. The penalty for not producing food under such conditions was Rs. 10 per acre. It was the experience of some coconut planters who grew manioc on their estates, that the yield of nuts had failed by 2/3rds. To get the land back to normal three years of intensive manuring had to be done. He remarked: " It should not be assumed that all wisdom lies with the Government." Whenever planters through their own efforts increased their yields, that too was taken away by Government in the form of direct or indirect

taxation. He reiterated that planters were ready to co-operate. He had the privilege of being in more than one of those Associations and he was fully aware that each and every planter was willing to help and co-operate with the Government. He appealed to Government to enlist the co-operation of planters and see that they were as much concerned in the welfare of the country and in production of food and helping the country to tide over the present crisis. He added, " It is not to be supposed they are merely existing for the provision of necessary funds to carry on the Government. They will do that though they do not expect favours."

The next point he would like to touch upon was the rise in population of a country in relation to food production. He wondered whether it was out of order for him to bring up that matter for discussion but requested the Chairman to rule him out if it was considered out of order. The population of the country was increasing at the rate of 200,000 a year so that in 5 years the increase would be a million. He pointed out that that would present a big problem despite the increased production of food if there were a million more mouths to feed every 5 years. He would not say whether family limitation in a country like Ceylon was necessary but pointed out that that was a question to be examined closely by Government. He stressed the importance of family planning for the wellbeing of the country.

At this stage a member remarked—" He has passed his stage," and the whole roared in laughter.

Mr. Gunawardena continued that it was not a matter to laugh but it was a serious question for the Government to consider. He admitted that in a matter of that nature religious sentiment would play an important part but nevertheless it was necessary to examine the problem.

Referring to the production figures and the statistics which were revealed at the previous address on Food Production, he said he was intrigued by the figures which indicated that there were 900,000 acres of paddy in the Island and that the average production was 30 bushels per acre in Maha and 29 bushels per acre in Yala. At that rate, he emphasised that the country should be able to produce sufficient rice for 13 million people. From his experience of paddy cultivation in the Kurunegala District, the maximum yield per acre in Maha was 40 bushels and in Yala it was not more than half that amount. In places where the yield was 10 to 15 bushels, even after manuring he had not been able to get more than 20 bushels. He felt that people whose paddy lands were situated at the foot of hills and in valleys might have experienced bigger yields but he was talking of fields on flat land. Therefore it was his contention that the figures quoted were far excessive.

He also observed that while it should be Government's policy to allot land to peasants, it should also consider the feasibility of allotting large acreages to companies who were prepared to grow food on a commercial basis. That, he said, would definitely increase food production in the Island because large tracts of land available in the Dry Zone could be made use of. He had read in the papers that there was a change of Government policy within the last one or two months and that it was to consider a scheme of allotting land to companies and groups who were prepared to venture out on growing food crops. If that were the policy he said he would congratulate the Government because it was a step in the right direction.

Mr. C. P. de Silva, M. P.—" Mr. Chairman and Gentlemen—Production of food seems to be our main problem today and also our difficulty in the production of food is not merely a problem of agriculture but a problem of economics and also politics. With more systematic agriculture it is possible to raise all the food we want in this country—by food

I mean cereals including flour. Mr. Chairman, even at Rs. 12 a bushel of paddy, could you say that the capital and labour employed in the production of rice will give the same dividend as capital and labour engaged, for example, for coconut, or rubber or tea? Consider the capital required to aswedduмize an acre of land. It is not less than planting an acre of tea, coconut or rubber. The price of Rs. 12 per bushel was only recently introduced, but till 1942, the price of paddy was one rupee a bushel. What we are facing today is due to the policy of the Government at that time. At that time, till quite recently, it was not worth spending money and labour in the production of paddy. Therefore we saw large extents of tea, rubber and coconut being planted and the cultivation of paddy was left to the villagers and peasants whose resources would not permit them to do anything else. If their resources did permit them, probably they would have given up paddy and taken up to planting tea, rubber or coconuts, or something else. That has been happening all over the country. Whether we are encouraging the production of paddy, onions or chillies, the question of net income must be taken into account. The value of the labour employed must be taken into account. You must not take the gross income from an acre of paddy and consider the net income. The landed proprietor would consider only the net income. That man, the peasant was till recently treated with supreme contempt. His labour was not considered, his gross income was not taken into account. That must be corrected before we think of making food production a national effort. It was the British policy that had kept the prices of food down. It was a political matter and they were able to keep the prices of food down in order to keep down the wages. When wages were low they were able to open up Tea and Rubber Estates cheaply and have factories. It is national policy today to produce food. Political power is in the hands of the peasant because they command the majority of the votes and they demand now more than their share. That is why Mr. Chairman there is trouble in all South East Asian countries where paddy is grown. One of the causes of the problem in Malaya is that they cannot sell their rubber in the best markets because they do not have the franchise. If we did not have our franchise and also the authority to look after our own affairs, our rubber would not have fetched the best market, so that the production of food depends not only on agriculture but on economics and politics. " He hoped that the Hon. Minister would consider those two matters, namely, a more systematic form of agriculture and a better price to the producer in keeping with the income from other forms of agriculture.

He continued that the total amount of paddy land was one fourth the extent in Ceylon of which 25 per cent. was under major irrigation schemes and 75 per cent. under minor village schemes. 33 per cent. of the paddy produced in Ceylon came from major schemes, that was 1/3rd and 2/3rds came from minor schemes. He said as Mr. Godamune had stated earlier, Government should concentrate more on the minor schemes. The Government was spending 43 million rupees on major schemes and only about 3 million rupees on minor schemes. Mr. de Silva emphatically reiterated the need for an immediate change of policy and said " unless there is a change of policy there is no use in talking shop here. " He emphasized that the attention necessary for those agricultural schemes could not be given and would not be given until there were two Departments of Irrigation, one for minor works and the other for major schemes. He explained that under the present set up it was not possible for the Irrigation Department to concentrate on major schemes and at the same time give their attention to minor works. The cream of the Irrigation Department is concentrated on major schemes and the minor schemes were some sort of poor relation. He said that just as land development activities and food production activities were separated into two departments it was essential to establish a separate Department of Irrigation for minor works. It was his experience, when he was Director of Land Development, that there

was no time to concentrate on Colonization Schemes and on Food Production. Although he had to do it, it was not possible to do a real job. The Peasantry Commission report had estimated the cost of all the minor works at nine million rupees. The Director of Food Production stated that 2½ million rupees were provided for minor works and 1 million rupees for land development. That was roughly one third of the estimated amount so that a third of the work could be completed, but still the Irrigation Department had not been able to do it. With the present staff and the present organization the Irrigation Department would never do it and they would not have the time to do it.

Referring to the mismanagement of certain Agricultural Production & Sales Societies, Mr. de Silva said that those Societies could easily be made to work satisfactorily if the Audit side was good. He also added that the supervisory staff in most of those Societies was no good. He observed that some of those frauds ranging from 60 to 70 thousand rupees could easily have been checked if there was proper auditing and the only solution was for each Society to engage the services of a Chartered Accountant because most of those Societies could afford a Chartered Accountant's fee.

In regard to the question of tractors he said he would like to point out that C. A. P. & S. Societies were buying tractors from any and everywhere without careful selection to suit conditions. He also emphasized that he had seen 20 tractors at work in the Minneriya Colonization Scheme during the last Maha season and that the ploughing was so deep that all the sub soil had been turned up causing a great deal of harm to the crops. The result was that the crops were yellow. He said that it was surprising that no Agricultural Officer or some such person had stopped that ploughing. He said that even the most junior Agricultural Instructor would have realized the harm done by such bad ploughing. Therefore he believed that there was something lacking in that organization. Even in the matter of purchasing tractors he said that a large number of tractors had been bought without the buyers calling for tenders. He said that it was not possible for them to go on like that spending the little money they had, unless proper use was made of the money spent and the whole business was carried out in a prudent and business-like manner.

Going into the question of substitute food crops, Mr. de Silva explained that the villagers were used to growing kurakkan and that it was the ancient substitute for rice so that there was no use in the Agricultural Department trying to encourage maize in one season, menneri in another season, and adley, sorghum, &c., at different periods. Kurakkan was not a new crop to the villager and he had nothing to learn in its cultivation. He remarked that his political party strongly supports kurakkan! He said that the villager knew all about kurakkan—how to grow it, how to preserve it and how to cook it. He therefore suggested that it was best to stick to kurakkan. He felt that perhaps the Department did not like kurakkan because it was a chena crop. He said that if chenas are to be discouraged, it was for the Department to teach the villager a better method of cultivation to replace the wasteful chena. He suggested that that could be tried out in some of the dry farming schemes like Pelwehera and Relapanawa.

Mr. N. H. Keerthiratne, M.P., suggested that in order to save expenditure, the present Anti-Malaria D. D. T. unit could be made use of for pest control work. He said that pest control was very essential because 20 to 30 per cent. of the crop was lost owing to damage by pests.

He also observed that at present there were large paddy areas which suffered for want of water and that the introduction of a drought-resistent paddy would solve that problem to some extent. He requested the Department to try *Elwee* which in his opinion was drought-resistent. Mr. Keerthiratne also suggested that an exchange of seed paddies during harvesting be arranged through Rural Development Societies.

In regard to the difficulties experienced by colonists due to shortage of buffaloes and tractors for ploughing, Mr. Keerthiratne suggested that the Government should not only give colonists the land for cultivation but also buffaloes for their work. Where necessary tractor ploughing could also be undertaken by Government, so that if there was a shortage of tractors the colonist could get on with his work by using the buffaloes. At present the experience was that when tractors fail, there were no buffaloes and no tractors. He urged that if it was Government's intention to have tractor units, it was essential to have a follow-up scheme.

Mr. Keerthiratne also mentioned that if any success was to be achieved in the matter of food production, the allotting of three or four acres to each would not solve the problem. But it would serve a better purpose if landless people were formed into companies or co-operative schemes and were allotted large acreages so that the profits could be divided among the shareholders. He said that as the present problem was one of food production it would be feasible to uproot coconut and plant food crops. He believed that certain coconut lands in flood areas bordering the Kelani and the Kaluganga could easily be converted into paddy fields and that water could even be pumped into the fields. He suggested that Government could buy some of those fertile coconut lands and convert them into paddy fields.

At this stage when most of the members laughed at that idea, Mr. Keerthiratne replied—" It is not a thing to laugh. Coffee gave way to tea. You know that coconut and rubber should give way to paddy if it is essential for the good of the country?" Then came a suggestion from the House—" Asweddumize Colombo! "

Mr. Keerthiratne replied—" It is only a suggestion, the Hon. Minister can implement it if he wants. "

Mr. Keerthiratne also spoke at length on the usefulness of tapping underground water so that the cultivator may not be dependent on the reservoir and the tank alone. He also suggested that Government should go into the matter of ascertaining whether it was possible to stop to any extent the evaporation of water from the existing tanks and reservoirs.

Mr. C. Wijesinghe commenting on the food problem said that Ceylon was at the mercy of other countries in the matter of food and that the country was still not in a position to get them to our shores. He agreed with Mr. Godamune's suggestion of holding propaganda meetings and discussion with the cultivator and the peasantry so that they could express their difficulties on a common platform. He said that that would create an incentive among cultivators and would be an encouragement to the villager. He said that they should also be in a position by right to have a proper share for their labours. He therefore suggested that the Paddy Bill should not only be introduced in certain districts but should apply to the whole of Ceylon.

Mr. Wijesinghe also emphasized that the present practice of withdrawing coupons from farmers was a great discouragement to the producer. He said that the farmer alone should not be deprived of the rice subsidy. He suggested that as an encouragement to

the farmer he should also be given the subsidy but if there was a crisis in the country, the Government could compel the farmer to sell his entire output and he should be made to depend on his coupons.

Mr. Wijesinghe stressed the need for giving every encouragement to the people of this country to change their dietary habits because substitute foods contain more carbohydrates. He felt that if the present subsidy on rice was withdrawn more people would take to substitute foods. He emphasized that the rice subsidy should be withdrawn completely and said that it was not going to harm the population of this country. He said that owners of estates were tied down by wages boards but if the subsidy on rice was removed the labour would be benefitted in the way of higher wages so that they could not merely think of rice but substitutes which could be bought with their higher wages. That would not only benefit the workers but the Government also would be benefitted because the Government could save the large amount of money spent on the subsidy and then it would not be necessary for Government to tax every pound of tea, rubber and copra to the same extent.

In regard to the purchase of tractors for mechanized agriculture in this country, Mr. Wijesinghe gave a warning that in Punjab hundreds of tractors were lying idle because at the time of purchase no arrangements had been made for their servicing or for replacements. He hoped that Ceylon would benefit by the experience of India and suggested that whenever tractors were ordered, the manufacturing companies should always be asked for servicing arrangements and for replacements.

In conclusion Mr. Wijesinghe pointed out that the paddy tax imposed at present was very irregular and appealed that Government should withdraw all taxes on paddy if paddy cultivation in the Island was to be encouraged.

At this stage the House adjourned for lunch at 1.10 p.m. and resumed proceedings at 2.10 p.m.

Mr. A. Perumynar spoke at length on the necessity of restoring minor irrigation works all over the Island. He also pointed out that shareholders were called upon to perform annual labour on those tanks and that they were levied a water tax of about Rs. 8 per acre. On major schemes the water tax was about Rs. 5 per acre. He suggested that the Irrigation Department should take up the responsibility of maintaining minor tanks with their labour and that the water tax levied at present should be reduced. He had learnt from an old document that the Irrigation Rules were framed in 1933 and that certain rules which demanded forced labour were revised. He added that the rule compelling shareholders to perform a certain amount of labour in Village Committees was abolished about 20 years ago. He therefore suggested that if it was the intention of Government to reduce the burden of the peasant, the rule in regard to maintenance of tanks by shareholders should be withdrawn, because more or less it amounted to a form of forced labour. In the alternative he suggested that all tanks should be repaired and attended to by the Irrigation Department and that villagers should be given sufficient assistance to improve their tanks after which they could be expected to look after their tanks.

Mr. Perumynar also stated that there were a number of village tanks in areas which had been declared forest reserves. He said that those areas had been declared forest reserves about 40 years ago and that the villager would be benefitted to a considerable

extent if those tanks were improved and given over to the villager and that some highland elsewhere could be found for forest reserves. He said that if that were done, they would definitely be making a contribution towards bringing a larger acreage under cultivation.

Mr. Perumynar commenting on the lack of sufficient land for cultivation suggested that land surrounding village tanks which could be irrigated should be made available to cultivators. He believed that in October, 1952, the Irrigation Department went into that question with each Revenue Officer. He said that there were in each revenue district a number of Village Cultivation Officers who had been given two years' training, one year by the Director of Irrigation and another year by the Director of Agriculture. They were now attending routine duties whereas the services of some of them could be more profitably utilized to look into the question of village tanks.

The next point Mr. Perumynar stressed was that, not merely the peasant, but every member of the community irrespective of his working conditions or income should be given land and irrigation facilities to produce food. He said he knew of people who had the means, the necessary resources and the labour and the knowledge who were willing to undertake paddy cultivation as a profitable venture but they did not have the facilities for obtaining the necessary land. He therefore advocated a change of Government policy which would enable not only the peasant but also the middle class and the capitalists to be alienated extents of land for food production. He also suggested that it would be a further inducement to the people if those who made a real contribution towards food production were recognized by Government by the award of medals and conferment of local honours.

Mr. N. M. Abdulcassim Marakar spoke at great length on the invaluable services rendered by the Hon. the Minister for Agriculture and Food during the war years when he was Civil Defence Commissioner and emphasized that he could confidently assure the House that as long as he was the Head of the Agricultural Ministry, there was no fear of starvation in the Island, and that the country's food problem would be solved. He also enumerated the various directions in which the country had advanced since the achievement of independence. He reiterated that since independence was gained there had been a marked increase in the paddy yields of the country because the Government was doing everything possible to help the cultivator. In his own district the yield of paddy was only 10 to 12 bushels in the years gone by, but he was proud to say that the yields have now increased to about 35 or 40 bushels per acre.

Mr. Abdulcassim Marakar's main suggestions were that immediate plans should be set up for production of high-yielding and flood resistent strains of paddy and that investigations be carried out on manuring to determine the best manures that would be suited to different paddy areas. He also emphasized the need for a number of Paddy Research Stations and sub stations throughout the Island.

Mr. N. R. Rajavarothiam, M.P., said that he had only one request to make and that was—" Give us more land and more water. "

Mr. V. G. W. Ratnayake, M.P., Parliamentary Secretary to the Ministry of Lands and Land Development, gave the assurance that land would be available for alienation in some of the provinces for paddy production under village tanks. He said that that process of alienation was under village tanks and that full investigations would have to be completed before alienation so that the cultivator would get the necessary directions as to where the tank should be sited so that tanks and crops lower down would not be affected.

He said that technical assistance so far in the matter of construction of tanks had been of a minor nature but that in future no tank would be reconstructed without sufficient technical assistance. He mentioned that lands would be alienated to peasants, middle class people or capitalists. The terms of the alienation, he said, would be a fairly long lease of about 30 years. In regard to the abandoned tanks he said that so far the Department could not devote adequate attention owing to lack of technical personnel and finances but he mentioned that such work would be taken up very shortly. He added that just now about 50 per cent. of the personnel of the Irrigation Department was employed on village tanks and he did not think that they could do more than that for the present. He felt that most of the village works could not be expedited because, as members of District Agricultural Committees who were present would be aware, there was a rule that village works upto a maximum of Rs. 5,000 only could be carried out by the Revenue Officer and that for any job exceeding that amount, the Revenue Officer had to consult the Irrigation Department.

He said that there was another request made that abandoned village tanks within forest reserves be made available to cultivators. He observed that forest reserves were essential and that that matter could be solved if the Forest Department could take in exchange from elsewhere the extent of land given over from their reserves. He said that alternative could be suggested to the Conservator of Forests if the same extent of land as that covered by the forest reserves could be found for the Forest Department in the same revenue district. He gave the assurance that both the Director of Irrigation and the Conservator of Forests would co-operate in that matter.

Mr. Ratnayake said he had observed a great deal of improvement in paddy cultivation within the last two years and complimented the Department of Agriculture for its achievements. He added, " I must stress that we can do more if we get the officers to change their hearts and their minds. " He emphasized that the officers should not expect the farmer to come to them but they should go up to the farmer. He said that the Director of Agriculture and the Director of Food Production should carry home to the farmer all what they had done through extension and research for increased production. He felt that it was no use cultivating large extents and realizing small yields but the policy should be to cultivate small acreages and realize large yields.

In regard to the question of pureline paddies, Mr. Ratnayake mentioned that he had, as an M.P., as a cultivator and as a planter, brought to the notice of the previous Minister of Agriculture, the present Prime Minister, the dire necessity to establish a Paddy Research Institute in the Island. He reiterated that from 1948 he had been stressing that point but it had not taken shape. The previous Minister had told him that various officials had various views on that matter and that the views of the various Directors of Agriculture were different from one another. Mr. Ratnayake emphasized the immediate need for establishing a central Paddy Research Institute if the paddy industry of the Island was to be established on a better footing. He said that there was no reason why a central research Institute should not be established for an important industry like paddy when all the other major industries of the Island such as Tea, Rubber and Coconut had each a Research Institute. In conclusion Mr. Ratnayake said that if it was the intention of Government to make the country self sufficient in food, the first step should be to establish a central Paddy Research Institute.

Mr. H. Abeywickrema, M. P., commenting on the cattle nuisance said that if any success was to be expected in the food production drive the first and the foremost thing was to find out a solution to the cattle nuisance owing to which about 20 per cent. of the produce of the Island was lost.

Mr. Abeywickrema also stated that although there were several conferences taking place at Kachcheri level, D. R. O. level and Village Headman level, much progress had not been made in the villages. He remarked that as a villager living in a remote part of the Island he could say that not a single additional acre had been brought under cultivation in the villages. He also emphasised that at District Agricultural Committee meetings where Government Agents, Assistant Government Agents and D. R. OO were present, big targets were arrived at but not even a part of those targets was achieved. He mentioned that sometime back at Galle, the D. A. C. meeting arrived at a target of 200 acres of chillies but he could challenge that not even an acre of chillies was planted out.

Sir James P. Obeysekera observed that the country should be extremely careful about her soil. Most people cultivated two seasons with paddy and the result was that production was going down.

In regard to food production in coconut estates Sir James pointed out that it was possible to grow yams under coconut but as coconut was a plant that feeds on surface roots all the fertility was absorbed by the yams and as a consequence a good part of the coconut yield was lost. He therefore emphasized that growing food crops under coconut was uneconomical and acted very adversely on the estates and their yields and that the food crops grown under such conditions were also not very satisfactory.

Sir James supported the view that wherever possible forest reserves should be made available for food production if it did not interfere with weather conditions or existing springs. He mentioned an experience he had of obtaining a forest reserve of 40 acres which was marshy and not far from the sea. He said he managed to get it with much difficulty after three years of correspondence. He felt that wherever possible, land should be released either from crown forests or village forests.

Gate Mudaliyar N. Wickremaratne disagreed with the member who spoke about family planning and birthcontrol and urged the need for greater production of food by the peasantry who should receive every facility and encouragement for so doing. In a country where food can be grown, first attention should be given for food production.

Gate Mudaliyar N. Wickramaratne referring to the remarks made by Mr. Abeywickrama to Stray Cattle emphasized the need for preserving the cattle population of this country and suggested the establishment of pasture grounds and grazing grounds. He said that the country should not be made to depend on imported milk foods and that it was essential to encourage every villager to own a cow. He added that their difficulty was lack of grazing grounds and some of them even experienced difficulty in finding the ropes to tie the cattle whereas in the olden days the villager used certain creepers from the jungle as ropes for tying their cattle.

Gate Mudaliyar Wickremaratne complimented Mr. Ratnayake for his suggestion for the establishment of a Paddy Research Institute and said that Mr. Ratnayake was a student of the School of Agriculture and it was a pride to see him in that position. Mudaliyar Wickremeratne however felt that one Paddy Research Institute would not do for the whole

Island and that there should be at least 50 such Research Stations. He said that it was not so much for research that those Stations were necessary but for producing a sufficient quantity of pureline seed. He remarked that unless that was done the country would take 900 years to produce sufficient purelines for 900,000 acres.

He supported Mr. Godamune's view that " Ulpaths " and " Pathahas " should be reserved. He said that there was not enough time for the Ministry to make a plan for bringing under cultivation a larger area of paddy fields during the Maha Season and emphasised the necessity for the drawing up of a plan for Yala and working according to plan. He stressed that very little could be achieved by discussion with big officials but if the Department could send out its officers to every village to find out the needs of the cultivator, such as the acreage he was bringing under cultivation, and afforded the necessary facilities to the cultivator, more could be achieved in the way of food production.

In conclusion he said that if the Food Production Drive was to be a success, it was very essential that the Land Development Department, the Food Production Department and the Agricultural Department should co-ordinate together.

Mr. K. Morford said he was impressed at the sucress of the Agricultural Extension activities in the Island and felt that the officers of the Agricultural Department had far too much to do so that there should be no reduction at all either in the number of Agricultural Instructors or Food Production Officers.

Mr. Morford also felt that the steady decline in the milk production of Up-country districts was due to the transport of animals from Up-country estates to Colombo where the animals were milked dry, not looked after well and became utterly unproductive.

Mr. S. Vytilingam, M. P. was of opinion that where there was unsufficient water for paddy cultivation, kurakkan should be grown. He also added that if kurakkan was transplanted, a yield as high as paddy could be expected. Mr. Vytilingam also supported the view that old village tanks and ponds in paddy tracts should be restored. He said he would also support Mr. C. P. de Silva's suggestion about bifurcation of the Irrigation Department. He said he was glad to learn that 50 per cent. of the officers of the Irrigation Department were employed on minor irrigation works. He was aware of a certain tank for the restoration of which the villagers were agitating for a long time. After much agitation last year the work was done but the tank had gone dry. He emphasised that those were matters of detail which with a little care could go a long way.

Mr. Vytilingam said that as Mr. Morford had mentioned estates were producing a lot of milk and that estates could help in the matter of food production by increasing their milk supply. He also mentioned that estates could help solve the food problem of the country by encouraging small industries on estates like poultry breeding. He said that the Government should take a hand in the encouragement of that industry on estates and emphasised that when Government had lost much money on several other industries, there was no reason why it should not support a small industry like poultry breeding.

Mr. Kanagaratnam brought out one or two instances to show how Government business is delayed unnecessarily by having to observe too many rules and regulations. In that respect he said, he could pay a tribute to the Hon. the Minister of Agriculture and Food

with whom he had the pleasure of working, during the war years. He did not believe in regulations but he saw to it that the work was done and that was how he achieved so much success in his food distribution scheme during the war years. He was known as the " Distributor Dictator " and he gained the confidence of all who worked under him. He therefore hoped that the Hon. Minister would adopt a similar attitude in the present food crisis if the food problem was to be solved. He said that three years ago he had interested himself in an offer that came from the Malayan Pensioners Association to cultivate 3,000 acres of paddy in Ceylon but he was sorry to say Government had hitherto taken no action about it. He said he was not making a complaint but he brought it up to show what could have been done three years ago if prompt action was taken.

The second point he would stress was that food production in the Island should be considered as a national service and that the Government would have to harness the services of the youth of this country. He said that some years back when colonization schemes were started, the Colombo Y. M. C. A. undertook the task of finding a number of youths to go to Minneriya. He emphasised that today with so much of unemployment in the country if Government could only select a 5,000 acre block and utilized the youth of the country for producing food, there was no doubt that much could be achieved in that direction. In conclusion he said that the Hon. Minister was " Food Distribution Director " in the war years and hoped he would now be the " Food Supply Dictator. "

Mr. Marcus S. Rockwood said that there was already a philippi for food production and urged the Hon. Minister to see that there was better co-ordination between production, transport and distribution. He suggested that the farmer should be made to feel that his only job was to produce and that he should be absolved of all other responsibilities such as transport and distribution.

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture made the following comments in reference to certain observations made by previous speakers.

In reference to Mr. Armstrong's comment that plough shears turned out by the Government Factory wasted quickly and were of an inferior quality he said he agreed that the complaint was quite correct and that the Divisional Officer too had informed him about it. He said that action had been taken in the matter and hoped that the defects would be remedied soon.

In reply to Mr. Rockwood's query what the 195,100 bushels of seed paddy issued would represent in acres, he said that if the whole extent was transplanted then it could be worked out in bushels per acre. Therefore he said that the figure had to be divided between those two categories. Mr. Rockwood had also asked how much paddy had been raised as a result of the issue of the pureline seed. He replied that this Department is unable to give production figures but that they may be obtained from the Director of Census and Statistics. The Agricultural Department did not have the facilities to work out such details.

The question brought up by Mr. A. F. R. Gunawardena was that if there were 900,000 acres of paddy in the Island and if the average yield was 30 bushels in Maha and 29 in Yala, the country should produce sufficient paddy for 13 million people. Mr. de Mel replied that that question was undoubtedly interesting and that the figure quoted would

seem ridiculous; but on closer examination it would reveal where the error was. He said that in the first place he would point out that 900,000 acres was the total area cultivated for both seasons. Therefore it was wrong to take the average yield and calculate for two seasons as though 900,000 acres were under paddy each season. Besides that error, there were other factors to consider; for example there was always a likelihood of the total area not being cultivated due to failure of rains, &c.

In regard to the question raised by Mr. Sivapalan about the figures of yield for Trincomalee given by the F. A. O. Statistician, he said that the yield was undoubtedly very high. The figures given represented only the average. He added that according to the average for the whole of the Jaffna Peninsula the figure was 13 bushels per acre but for the Karachchi Scheme which represented one fifth of the whole area the figure was 30 bushels per acre. In the Kalutara District the figure was still less and represented only 17 bushels per acre. The low figure in Kalutara was due to certain fields which were marshy fields or affected by salt water. He said that especially in the Dry Zone the figures of yield were very high. In places like Maha Divulwewa there were fields which yielded as much as 80 to 100 bushels per acre whereas the average yield for the whole Island was only 30 bushels per acre.

In regard to the point raised by Mr. Godamune about the feasibility of holding mass meetings among villagers, and Mr. Ratnayake's observation that the officials should go down to the farmer, Mr. de Mel emphasised that that was already being done by the Department and that there were Propaganda Field Days at which the officers actually met farmers. He said that there were mass meetings and transplanting drives held at present, and that the new set-up enabled Village Headmen, Vel Vidanes, Overseers, Rural Development Officers, &c., to assemble at these and come to know the problems of the farmers.

Replying to another question by a member Mr. de Mel said that the Department had taken up the matter of growing millets and pulses on fields which were not cultivated with paddy and that cultivators would be encouraged to do so.

Sir Oliver Goonetilleke, K.C.M.G., K.B.E., Minister of Agriculture and Food— Mr. Chairman and Gentlemen, I was deliberately giving all the possible time of this important Conference to my listening to the views of those present at the meeting. I think I have benefitted and the Ministry has benefitted a great deal by that arrangement. There are just a few points arising from the observations made which I like to touch upon in concluding the proceedings of today. I do not propose to clear any debating points because the last thing I as Minister should do is to give to you an impression that I do not like a free voicing of your sentiments even if I do not agree with some of them. All who are here in this Conference belong to the oldest party in Ceylon and I think will always be the over-riding party in this country. We belong to the party of the Central Agricultural Board. If we examine our problems against that over-riding responsibility, I think, Sir, today's discussion has brought out many points of value. I would almost venture to say that I have heard nothing that has surprised me when I eventually fall back on the source from which the comment has come or from the background of experience of the person speaking. Mr. C. P. de Silva, Mr. Kanagaratnam and the Adigar speaking from the background as retired public servants had a somewhat similar outlook on many problems. The Registrar of Co-operative Societies I think, has already felt how unreasonable, probably in his view, I react to any financial irregularity in the Co-operative Movement. I forget almost completely

that they are independent people. It is very important, as everybody in this room would expect, that a movement, in regard to which no section of thought in Ceylon has any doubt as to its desirability should take every possible care in the handling of its finances, in the maintenance of its accounts and in the promptness of its duty. I think, indeed I would be failing in my duty and in my past experience if I do not at least bring that special contribution to my work as Minister of Co-operative Undertakings. I think Mr. C. P. de Silva would always bear in mind the importance of that period of our co-operative work. I always tell co-operative movers that it would indeed be a crime against the Co-operative Movement all over the world if the movement in Ceylon were to disturb in the slightest degree that feeling of reliability on a loan given out by a Co-operative Society. And here in Ceylon you have probably understood by now that my policy is to make the Co-operative Movement the complete mainstay of rural credit in Ceylon. I think we are succeeding throughout the length and breadth of this Island in freeing the farmer from the grip of the rapacious money-lender. The means that Government assistance in the way of loans must be increasingly available to Co-operative Societies. It means that the Committees of these Societies should have a personal and intimate knowledge of every single borrower. It means that the registration of your Society must be so composed and the size of the Society so limited that it is humanly possible for the Committee to know the members personally. If we lend money in large amounts, without the precaution that the Committee lending the money knows personally the applicant, then we are removing the efficiency and the reliability of the Co-operative loan.

Not only is the Government utilising the Co-operative Movement for rendering rural credit, it is also utilising this movement as the sure machinery for the guaranteed price scheme. Recently events have occurred in regard to which probably a word or two of instruction from me might be helpful. It was mentioned in connection with the difficulties of obtaining seed paddy that the market price of paddy was very much higher than the guaranteed price. The policy of Government today is to maintain a sellers' market for locally produced food. We have deliberately decided whatever the price of rice may be in the markets of the world, to import in the next 12 months 82,000 tons of rice less than we imported in the previous 12 months. What is the purpose of it? The purpose of it is not to have a repetition of what happened in the Colonial days. The imports of cheap rice from other countries would prevent the growth of the local paddy industry. I am delighted to hear from all quarters that in this somewhat curtailed harvest owing to bad weather, owing to the absence of full monsoonal rains, the cultivator is today selling his paddy at Rs. 18, Rs. 19 and Rs. 20 per bushel. I would be happier if in the next few months he gets Rs. 25 for a bushel of paddy. Please do not listen to the complaints of the consumer in this connection. So far as the consumer is concerned he gets a part of his rice at the subsidised figure. If he has not got the money to pay for the market price of rice, he has a perfectly good and almost a better substitute in substitute grains and in flour. I cannot stop the people of Ceylon who have money to drink champagne from spending their money on such luxuries. My answer to those who want to consume more rice than their rationed quantity and complain that the free rice is sold at a high price in the markets of Ceylon is, you need not buy that rice. You get flour and you get other substitutes. Flour today in Ceylon is the cheapest flour anywhere in the world.

Therefore Sir, there is no cause for starvation and I beg of all of you not to encourage squealing against the producer or against anybody who handles the sale of paddy. As I said on a previous occasion, if the trader is black-marketing paddy you have the powers

of resistance to say to him—keep your paddy, I am going to eat flour instead. If consumers in Ceylon will take that to heart, we shall have no complaints from their side. I would repeat again that conditions have altered from the days in which you were encouraged to grow rice in Minneriya when the controlled price of paddy was Rs. 4 and then Rs. 6. Today the Government is telling the producer—sell your paddy at the highest possible price—and if he got Rs. 18, Rs. 19 or Rs. 20 per bushel we could say that at last the " goiya " has come into his own. Mr. Chairman, it is against that background that I want you to examine the two sets of complaints. One is the complaint of planters like Mr. A. F. R. Gunawardena that we have been spoiling the goiya. As against this, there is the complaint from Mr. Armstrong that the subsidy for manure is not enough. I think we have reached a stage, Mr. Chairman, in which the Government can tell itself that the concessions and assistance to the producer as such are adequate and that there is no ground for increasing them.

Sir, in regard to the other group of complaints, I would only say this,—I am more conscious than anybody else that the prosperity of this Island depends not only on the production of rice but on the maintenance and in the improvements of the three major products of coconut, tea and rubber. If in the implementation of the Grow More Food Policy certain difficulties had been in the way of planters, I must ask them always to bear in mind that at least a third of the colossal food subsidy that this Government has carried during the last five years has been in their interests and that their labour has been adequately fed, and at very special rates. I think planters could not help but read the news of difficulties with labour in the tea estates of North India. Their special food subsidy has got to be paid by the owner of the estate. Those proprietors have reached a stage in which that subsidy cannot be paid any longer and estates are closing down.

Mr. Chairman, the planting industry, in whose future I am so vitally concerned cannot say that we have weighted the case too much against them. I entirely agree that food production between tea bushes, under rubber trees and between coconut plantations as Sir James had said is probably a waste of effort, of labour and money. My Director of Food Production and I realised this quite early after the assumption of our responsibilities. I would rather wish if all of you stopped this food production on estates and paid me Rs. 10 per acre, towards a certain branch of our activity, a branch in respect of which the Director of Food Production hopes to see that a substantial improvement is effected entirely from the funds you pay, instead of trying to produce food. So I as your Minister of Agriculture, would welcome an increase in the number of those who pay the funds rather than an increase in the number of those who try unsuccessfully to produce food.

Mr. Chairman, we are at the conflict of opinion in regard to the difficulties of labour on the one side and the necessity of introducing labour-saving devices on the other. We certainly do not intend to overlook the bitter experience of other lands. I think those who were present at the inaugural meeting of the Board would remember that it was mentioned that we should take very great care with our tractor pools so that they would not in the years to come be cemeteries of broken down tractors. I do not think that in this unavoidable competition of labour, tractor companies will fill Ceylon with their untried makes of tractors. I think great care has been taken by the Societies that purchased tractors to see that only tractors in respect of which servicing arrangements were assured by the already existing units in Ceylon were bought and to make sure that spare parts were constantly

available. When it comes to the tractors that are being purchased by Government, we have the advantage of a great deal of experience in regard to this and I do not think we are likely to repeat the mistakes of a few years ago.

In regard to our very fortunate receipt of a gift of tractors from Australia, that Government takes very good care not to send us any machines in respect of which adequate servicing arrangements are not available. Just as much as that country is anxious to help us, it is also anxious to preserve the good name of its exporters of agricultural machinery.

And now, as regards that most important matter as was told us in one brief sentence by the Member for Trincomalee—" give us more land and more water, " while I accept this provisionally, nobody can say that the demand for more land has been the urgent problem. I would like to submit that more water is the real urgency, and when we have more water, more land will automatically be developed. I do not think Mr. Chairman that our Prime Minister or anybody in the Cabinet has the slightest inclination to the view that the Gal Oya Scheme alone would save Ceylon. The Gal Oya or the Walawe Scheme when completed would make extraordinarily valuable additions to our economy but our main hope for the future and our chief responsibility is in improving the cultivation of existing lands. Therefore Mr. Chairman, from all sides of this Conference one hears the demand for more money to be spent on minor irrigation works. It is, so far as your Minister is concerned, music in his ears. Mr. Chairman, we want more money. I think it is the Member for Matugama who said that even if we have the money we are still unable to spend it. I think Sir, in the last six months a considerable change has come over that position. There is no longer a case of money being voted and not being spent. We have, taking advantage of our experience, overcome the difficulty of the Kachcheri that gets an allocation and does not spend it, as against some hardworking A. G. A. as the Member for Polonnaruwa used to be, who was always overspending his votes. We make an allocation of 20 per cent. larger than the total vote so that we make sure that he would spend the total vote. Therefore, Sir, I think everybody who agitated in favour of increasing provision for minor irrigation works is doing a great service to Ceylon.

Mr. Chairman, there are many other points I would like to take up but I do not want to delay you much longer. I like to say a word in deference to the Malayan Pensioners. I have been twice to Jaffna in the last six months. I almost made up my mind that I could not go a third time to Jaffna until this problem brought up by Mr. Kanagaratnam was settled. I have had a personal interview with the Land Commissioner and I am hoping that before I leave for Jaffna in a few days time he might place in my hands the decision which will enable me to advise that group of Malayan Pensioners with the self-respect that a Minister should have.

Mr. Chairman, I said I was not only Minister for Food Production but I was also Minister for Tea, for Rubber and for Coconut. The battle of Ceylon today is a battle for increased production all along the line. I think in my inaugural speech I underlined this fact. There are some of those who look after their tea estates, the young plants of their coconut estates and the manuring of their estates but do not bother about food production. There will also be those who will very soon take advantage of the rehabilitation scheme for rubber and the replanting of rubber. The economy of Ceylon has suffered a jolt not because food is difficult to get, but because in order to maintain this standard of our living and our level of employment, our national income has not increased in keeping

with our requirements. Therefore to those who are devoting every possible ounce of energy towards increased food production I say, let us always bear in mind that the coconut tree, the tea bush and the good rubber tree are all equally important.

In conclusion Sir Oliver said—" Mr. Chairman, this important Conference is taking the shape I thought it would take. There are matters that you know but which your Minister will never know in a hundred years from now. There are local problems in regard to Ceylon in which only you can help. The Director of Agriculture and I, with the encouragement of Professor Hardy, Head of the F. A. O., has been considering during the last few weeks the specific point put forward by Mr. C. P. de Silva. It should not I think take the Department of Agriculture and the Ministry of Agriculture many weeks to spot out 50 acres suitable for that sort of dry farming cultivation. It is in ways like this that you can help. Therefore, Sir, again I stress how gratified I am to be with you and express the hope that you would not think your Minister too great a nuisance at your next meeting. "

Mr. A. M. Clement Dias whilst regretting his inability to attend the meeting made the two following suggestings in a memorandum submitted by him on the subject of increased Food Production for the consideration of the Central Board of Agriculture and the Government:—

1. That the services and co-operation of the V. C. Chairmen, Village Committee Members, Vel Vidanes, Village Headmen, Mahila Samities, other village Samities, Planters and other prominent members of the public be enlisted by Government in the campaign for increased food production.

2. That Government should award Medals in gold and silver and bronze to leaders and cultivators who have carried out exceptionally good work in connection with the campaign for increased Food Production. Such awards be made by the Governor-General or Prime Minister at a large gathering of prominent citizens in Colombo.

He feels that this form of public attention to participants in the campaign for increased food production would induce more and more members of the public to take to the production of food and thus make Sri Lanka self-sufficient in the matter of food in a short time.

Dr. A. W. R. Joachim, Chairman—" Gentlemen—we have had a very interesting discussion on the most important subject which is facing us at the present time, viz: that of food production. We had the great privilege and advantage of having our Minister who has addressed us in such a very interesting, remarkable and convincing manner. His being here has considerably lessened my responsibility as Director and Chairman. I shall send up for the Minister's consideration a full report on the matters that have come up for discussion today. I am sure that the valuable suggestions you have made at this meeting will help us to do a little more than what we have endeavoured to do in the matter of food production. I thank you Sir, very much for having come here to encourage us. I thank you all once again.

The meeting terminated at 4.15 p.m.

M. SIVANATHAN,
Secretary,
Central Board of Agriculture.

Peradeniya, March 8, 1958.

Rubber Research Institute of Ceylon

MINUTES OF THE 120TH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEAD QUARTERS, COLOMBO, AT 2.30 P.M. ON MONDAY, MAY 18, 1953

Present—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. G. H. Dulling, Mr. W. Herbert de Silva, Mr. R. J. Hartley, Major Montague Jayawickrema, M.P., Dr. A. W. R. Joachim, M.B.E. (Director of Agriculture), Gate Muhandiram Arthur D. S. Jayasinghe, Dr. H. E. Young (Director) and Mr. C. D. de Fonseka (Administrative Secretary).

Ir. J. H. Van Emden (Mycologist) was present by invitation.

At the commencement of the meeting the Chairman congratulated Major Jayawickrema on his appointment as Acting Minister of Transport & Works.

1. BOARD

A letter from Senator C. F. W. Wickremesinghe stating that he would be away from the Island from May 25 to September 30, 1953, was read and it was agreed that he be given leave of absence from meetings during this period.

2. MINUTES

(*a*) **Confirmation—**

Draft minutes of the meeting held on March 30, 1953, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) **Matters arising from the minutes—**

Sulphur dusting Smallholdings—The scheme outlined by the Director for assisting smallholders and small estate owners to sulphur dust their holdings was approved and he was asked to take the necessary steps regarding its implementation.

3. EXPERIMENTAL COMMITTEE

Recommendations made at meeting of April 27, 1953.

(*a*) *Community centres.*—Contracts awarded by the Committee for construction of community centres at Dartonfield and Hedigalla were approved.

(*b*) *Improvement of Asst. Staff bungalows.*—The provision of extra lighting points and a shower bath at each bungalow as recommended by the Committee, were approved.

(*c*) *Rubber Rehabilitation.*—Reported that, as approved by the Committee, Egal Oya Farm had been taken over for establishing a nursery for the production of budded stumps. Arrangements made in this connection were approved.

4. STAFF

(*a*) *Acting Director.*—Agreed that Ir. J. H. Van Emden, Mycologist, should act as Director during the absence on leave of Dr. H. E. Young with effect from June 9, 1953.

(*b*) *Assistant Staff.*—Changes in staff since the last meeting were reported.

5. TRAINING FACILITIES ON DEVELOPMENT PROJECTS

In response to a request from the Ministry of Agriculture and Food, it was agreed that training facilities be provided at the Institute for two students from abroad under the Colombo Plan Technical Co-operation Scheme.

6. REGISTRATION OF RUBBER SMALLHOLDERS CO-OPERATIVE SOCIETIES

Reported that the Registrar of Co-operative Societies had promised to have all the Co-operative Societies in which the Institute is interested registered within two weeks.

Members wished the Director a pleasant holiday.

The meeting then closed with a vote of thanks to the Chair.

Dartonfield,
Agalawatta, June 10, 1953.

C. D. DE FONSEKA,
Administrative Secretary.

RETURNS, &c.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED MARCH 31, 1953

Province	Disease	Fresh Cases during the Month	Total number from the beginning of this Calendar Year to March 31, 1953				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	2	1	—	1	—
	Rabies	20	50	—	50	—	—
Colombo Municipality ..	Rabies	7	18	—	18	—	—
Quarantine Station	Anthrax	4	4	4	—	—	—
	Pleuro-pneumonia	—	36	36	—	—	—
Northern Province ..	Foot-and-mouth	50	295	—	—	263	32
North-Central Province ..	—	—	—	—	—	—	—
North-Western Province ..	—	—	—	—	—	—	—
Central Province ..	Rabies	8	19	—	19	—	—
Province of Sabaragamuwa ..	—	—	—	—	—	—	—
Province of Uva	Rabies	—	1	—	1	—	—
	Piroplasmosis	—	2	—	—	2	—
Eastern Province ..	Rabies	1	1	—	1	—	—
Southern Province ..	Rabies	4	6	—	6	—	—

Department of Agriculture,
Peradeniya, Ceylon,
April 30, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON, MONTH ENDED APRIL 30, 1953

Province	Disease	Fresh Cases during the Month	Total number from the beginning of this Calendar Year to April 30, 1953				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	2	1	—	1	—
	Rabies	18	68	—	68	—	—
Colombo Municipality ..	Rabies	5	23	—	23	—	—
Quarantine Station	Anthrax	7	11	11	—	—	—
	Pleuro-pneumonia	—	36	36	—	—	—
Northern Province ..	Foot-and-mouth	23	318	—	—	302	16
North-Central Province ..	—	—	—	—	—	—	—
North-Western Province ..	Foot-and-mouth	15	15	—	—	10	5
Central Province ..	Rabies	4	23	—	23	—	—
Province of Sabaragamuwa ..	Rabies	1	1	—	1	—	—
Province of Uva	Rabies	—	1	—	1	—	—
	Piroplasmosis	—	2	—	—	2	—
Eastern Province ..	Rabies	—	1	—	1	—	—
Southern Province ..	Rabies	—	6	—	6	—	—

Department of Agriculture,
Peradeniya, Ceylon,
May 21, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, MARCH, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Anuradhapura	93·0	+1·7	71·9	+0·3	64	95	4·2	2·37	7	— 1·78
Badulla	82·7	+0·3	64·9	+0·7	72	94	5·4	4·83	12	— 0·22
Batticaloa	86·0	+0·6	75·5	+0·5	81	95	3·5	1·80	9	— 1·67
Colombo	87·3	—0·7	74·9	+0·9	76	93	5·7	9·46	16	+ 4·80
Diyatalawa	78·4	+1·1	58·8	+0·7	73	88	5·6	6·49	12	+ 1·60
Galle	85·8	—0·6	76·0	+0·9	78	91	5·2	7·42	19	+ 2·11
Hambantota	87·6	+0·7	75·3	+1·0	76	91	4·5	1·75	11	— 1·64
Jaffna	90·1	+1·4	77·5	+1·7	68	86	3·8	0·13	2	— 1·45
Katugastota	87·8	—	67·0	—	70	95	4·6	2·32	8	—
Kankesanturai	89·7	—	76·2	—	71	88	4·0	0·02	1	—
Kurunegala	91·9	—0·9	73·0	+0·9	64	90	4·8	5·18	10	— 1·10
Mannar	90·0	+0·7	77·0	+1·8	74	93	4·1	2·08	2	+ 0·24
Nuwara Eliya	71·4	+0·6	47·4	+1·1	74	90	5·1	2·57	14	— 1·52
Puttalam	89·7	—0·2	74·3	+1·4	72	93	4·6	4·99	14	+ 1·91
Ratmalana	87·7	—	74·8	—	73	90	5·4	4·69	15	— 1·79
Ratnapura	92·3	+0·3	72·9	+0·4	72	93	6·0	9·33	20	— 1·05
Talawakele	77·8	—0·1	55·9	+0·6	72	82	4·0	7·14	14	+ 2·52
Trincomalee	86·8	+1·4	77·1	+0·6	77	91	3·8	0·82	4	— 1·48

WEATHER SUMMARY, MARCH, 1953

Thunderstorms in February continued well into March without an appreciable break. They were, however, mainly confined to the south-western parts and the north-eastern slopes of the hills, so that very little rain was experienced in the northern half of the Island. Thunder activity has been severe again, at times, and was responsible for a few deaths. Dry weather that set in about the 22nd lasted till the end of the month. On the 27th, however, owing to unsettled conditions, moderately heavy rain was experienced along the south-west coast.

Monthly rainfalls were heaviest in the south-western mid-country, where several stations recorded totals exceeding 15 inches, the highest being 21.87 inches at Mawarella Estate, 21.79 inches at Udugama, 20.71 inches at Kalatuwawa and 20.52 inches at Opata. Elsewhere in the south-west and to east and south of the central hills the rainfall generally ranged from 5 to 10 inches, while to north of Anuradhapura-Trincomalee, it was mainly below 2 inches. No rain at all was recorded in some parts of Jaffna Peninsula and Mullaittivu District.

The bigger excesses above average also occurred in the south-western parts and ranged generally from 5 to 10 inches, the highest being 12.34 inches at Mawarella Estate, 10.66 inches at Udugama, and 10.64 inches at Kalatuwawa, while the bigger deficits (of the order of 2 to 5 inches) occurred in the central parts of the hill-country and in the North-Central Province. Deficits in these regions, particularly in the North-Central Province, are noteworthy as rainfall here has been consistently below the average during the last 6 months, causing acute drought conditions. The biggest shortfalls in March were 6.77 inches at Gampola, 5.59 inches at Mariawatta Estate and 5.28 inches at Orwell Estate.

There were no daily falls over 5 inches.

Day temperatures, were below normal along the west coast and above normal elsewhere, while night temperatures were above normal throughout the Island. The highest temperature recorded was 99.1°F at Anuradhapura on the 30th (higher than the blood heat), while the lowest temperature for a low-country station was 67.3°F, also at Anuradhapura on the 10th and for the whole Island 37.6°F at Nuwara Eliya

on the 26th. The mean day humidity ranged from 75 to 85%, except in the dry north-western parts where it was below 70%. The mean night humidity varied from 85 to 95%. Cloud amounts were above average, while the wind strength was irregular and the direction variable.

D. T. E. DASSANAYAKE,
Director.

Department of Meteorology,
Bullers Road, Colombo 7,
April 10, 1953.

METEOROLOGICAL REPORT, APRIL, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·0	+0·4	74·0	—0·5	71	93	5·1	14·71	21	+ 8·28
Badulla	84·0	—0·1	66·2	0	76	97	6·0	7·69	20	+ 0·69
Batticaloa	88·6	+0·7	75·9	—0·8	78	93	5·0	1·16	10	— 1·14
Colombo	86·7	—1·2	74·9	—1·0	79	93	5·8	25·87	25	+16·80
Diyatalawa	78·6	+0·8	60·4	—0·1	80	94	5·9	9·25	26	+ 2·71
Galle	85·3	—0·8	76·1	—0·6	79	91	5·7	11·72	22	+ 3·01
Hambantota	88·3	+0·6	76·0	—0·3	76	88	5·0	2·02	14	— 1·84
Jaffna	90·2	+0·6	80·5	+0·3	73	85	5·9	2·51	9	+ 0·28
Kandy	87·4	—	68·8	—	72	95	5·6	7·56	20	—
Kankesanturai	91·8	—	78·4	—	71	91	5·6	1·46	7	—
Kurunegala	91·2	+0·2	74·0	—0·7	67	90	5·4	7·41	18	— 2·50
Mannar	91·5	+1·2	77·5	—0·5	77	93	4·8	1·93	7	— 1·49
Nuwara Eliya	71·2	—0·1	51·6	+1·8	81	91	5·8	7·94	21	+ 2·96
Puttalam	89·9	+0·7	75·3	—0·8	71	91	4·9	3·58	13	— 1·30
Ratmalana	87·5	—	76·2	—	79	82	5·6	21·39	23	+10·82
Ratnapura	91·7	+0·6	73·3	—0·5	74	93	5·4	13·13	25	+ 1·56
Talawakele	77·6	0	58·1	+0·3	80	91	4·8	6·13	22	— 0·17
Trincomalee	89·2	+0·1	77·1	—0·5	75	89	5·8	4·18	12	+ 2·05

WEATHER SUMMARY, APRIL, 1953

Thunderstorms were well in evidence in April too, but the accompanying rain was mainly confined to the south-western coastal regions and to some places around the central hills, where rainfall was experienced on 20 to 25 days of the month. On a few days the rainfall was locally heavy, viz.:—on the 6th in the Kelani Valley Area ; on the 8th and 17th among the central hills and in the North-Central Province ; and on the 23rd, 24th and 27th along the south-west coast, while it was widespread over the Island on the 19th. Towards the end of the month first signs of the approach of the south-west monsoon were noticed, indicating the possibility of early setting in of the monsoon, when moderate rain-showers with gloomy skies were experienced along the south-west coast on the 28th and 29th. This rain did not extend beyond the coastal areas.

Persistent heavy rain along the south-west coast resulted in local flooding in the neighbourhood of Colombo and Negombo, the drainage systems being unable to cope with the large volume of rain water.

The greatest monthly totals were 28.40 inches at Sudupanawela, 27.63 inches at Weweltalawa Estate and 26.47 inches at Negombo, while those at Hunupitiya and Illukkumbura also exceeded 25 inches. Elsewhere in the south-western parts, among and around the central hills as well as in some parts of the

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North-Central Province the monthly rainfall generally exceeded 10 inches. Regions that received the least rain (below 5 inches) included the Eastern Province, the North-Western coastal regions and the Jaffna Peninsula.

As local thunder activity was chiefly responsible for the rain, excesses were found side by side with deficits. Excesses, however, predominated, those above 10 inches occurring along the south-west coast and around the central hills. The highest excesses were 18.81 inches at Illukkumbura, 18.37 inches at Negombo and 17.27 inches at Sudupanawela. Deficits exceeding 5 inches were 8.04 inches at Beralapanatara, 6.08 inches at Ella and 5.27 inches at Sirikandura Estate.

There were 13 daily falls over 5 inches, the highest being 7.02 inches at Negombo on the 23rd.

Temperatures were mainly above normal by day and below normal by night. The highest temperature recorded was 96.3° at Ratnapura both on the 2nd and 3rd, while the lowest temperature for a low-country station was also recorded at Ratnapura, 70.2° on the 13th. The lowest temperature for the whole Island was 43.1° at Nuwara Eliya on the 1st. Humidity ranged generally from 70 to 80% by day and from 85 to 95% by night. Skies were distinctly more cloudy, while the wind strength was below average and the direction variable.

D. T. E. DASSANAYAKE,
Director.

Department of Meteorology,
Bullers Road, Colombo 7,
May 13, 1953.

METEOROLOGICAL REPORT, MAY, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	94·4	+3·5	78·5	+2·2	62	86	3·5	0	0	— 3·54
Badulla	88·4	+3·1	65·8	—0·6	60	95	3·2	0·37	2	— 4·32
Batticaloa	92·2	+2·0	78·8	+1·0	73	86	1·8	0	0	— 1·79
Colombo	88·5	+1·5	79·9	+2·3	74	85	5·8	0·78	6	—14·71
Diyatalawa	82·6	+4·1	60·4	—1·7	66	86	3·9	2·74	9	— 3·32
Galle	85·5	+0·5	80·8	+2·7	78	82	4·2	1·87	9	—10·80
Hambantota	89·0	+2·2	79·6	+2·1	76	87	2·6	0	0	— 4·27
Jaffna	88·3	+0·1	82·8	+1·1	78	81	4·2	0	0	— 2·00
Kandy	88·2	—	69·2	—	64	92	3·4	0·01	1	—
Kankesanturai	92·9	—	82·8	—	69	83	3·6	0	0	—
Kurunegala	93·1	+3·9	77·8	+1·8	60	82	3·8	0·14	2	— 7·41
Mannar	90·8	+1·2	82·7	+2·0	77	85	3·9	0	0	— 1·79
Nuwara Eliya	74·7	+4·4	50·6	—2·6	72	90	4·0	0·01	1	— 8·46
Puttalam	90·7	+2·4	80·8	+1·9	69	85	4·8	0·41	3	— 3·36
Ratmalana	88·9	—	80·8	—	74	89	5·4	0·92	9	—15·49
Ratnapura	93·6	+4·7	75·5	+0·6	67	93	4·2	1·37	7	—19·54
Talawakele	79·2	+3·6	59·2	—0·5	75	91	4·4	0·43	3	— 8·98
Trincomalee	97·0	+4·9	80·2	+1·5	60	78	4·1	0·05	1	— 3·18

WEATHER SUMMARY, MAY, 1953

Although the south-west monsoon has been prevailing over the Island in May, the winds were exceptionally dry. Consequently, drought conditions, high temperatures and low humidity were the rule during the month.

For the south-western parts, this was the driest May on record, several stations with observations extending over 70 years recording the lowest totals. A few outstanding cases are, 0.01 inch at Nuwara Eliya and 0.27 inch at Colombo Fort the lowest May totals at these two stations in 83 years, the previous lowest

being 0.76 inch at Nuwara Eliya in 1910 and 1.90 inches at Colombo Fort in 1923 ; similarly, 0.70 inch at Kalutara and 1.37 inches at Ratnapura are the lowest in 84 years, the previous lowest at both stations occurring in 1894. Driest May previous to this has also occurred in 1894, but the rainfall in that year was higher.

In the Watawala and Matugama areas which receive the highest rainfall in May, the rainfall recorded was mainly below 7 inches, as against averages exceeding 25 inches. The monthly totals at Padupola and Gikiyanakande Estate were only 8.03 and 6.02 inches as against averages of 26.24 and 27.17 inches respectively, while that at Watawala was only 2.69 inches against 25.74. Elsewhere in the south-west, the totals were generally less than an inch, while the averages were about 15 inches. The only days on which rainfall to any appreciable extent was experienced were the 9th and 10th. Outside the south-west quarter the conditions were very dry, over 250 stations reporting no rain at all.

The greatest monthly totals recorded were 13.65 inches at Weweltalawa Estate, 8.79 inches at Metewiliya Estate, 8.44 inches at Carney Estate and 8.03 inches at Padupola.

The rainfall was below average throughout the Island, the greater deficits, of the order of 20 to 25 inches, occurring in the south-western mid-country and on the south-western slopes of the hills. The greatest deficits were 24.01 inches at Carney Estate, 23.29 inches at Kokkawita Group, 23.25 inches at Kumbaduwa Estate and 23.05 inches at Watawala. In the north and the east the deficits were generally below 5 inches.

Day temperatures were considerably above normal, particularly at inland stations, while night temperatures were below normal up-country and above normal elsewhere. The highest temperature recorded was 100.6° at Trincomalee on the 13th. This is a very rare occurrence, as temperatures exceeding 100° are rather uncommon in Ceylon. During the last 12 years this limit was passed only on 2 occasions, in 1948 and 1949. The lowest temperature for a low-country station was 70.6° at Ratnapura on the 20th, and the lowest for the whole Island, 44.3°, at Nuwara Eliya on the 18th. Humidity as well as cloud amounts were below normal, while wind strength was above average, the prevailing direction of wind being south-westerly.

A. P. KANDASAMY.
for Director.

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EDITORIAL

The Ceylon Citronella Oil Industry

CITRONELLA is an essential oil obtained from grasses of the genus *Cymbopogon* (*Andropogon*). The industry in Ceylon dates back to about the middle of the 19th century though the oil itself was known very much earlier. The grass is mainly cultivated in the South-Eastern part of the Island and covers an extent of over 30,000 acres in the Tangalle and Matara Districts. Citronella oil is the main industry of this area, the conditions for the economic cultivation of other perennial crops not being favourable.

Two main types of citronella grass, known respectively as *maha pangiri* and *lena batu*, are grown in the Island. About 75 per cent. of the total extent cultivated is under the latter type. The former, also known as *Java pangiri*, is the chief type cultivated on the rich volcanic soils of Java. The oil obtained from this variety of grass is of a superior quality to that from *lena batu* which is apparently a cross between the wild Mana grass and *maha pangiri*. The relative qualities of the two oils are determined by the " total geraniol " content, *lena batu* oil containing from 55 to 60 per cent. and Java oil from 80 to 85 per cent. of this constituent. The oils are used for different purposes, the Ceylon oil being utilized for soaps, perfumery and other technical preparations, and the Java oil mainly for the manufacture of synthetic isolates especially menthol.

Citronella is cultivated almost entirely by Ceylonese growers and, for the major part, by peasant cultivators, but there are a few large estates of from 100 to 300 acres extent. The standard of cultivation is poor and leaves much to be desired. Yields of oil are, therefore, low and average about 75 lbs. per acre. Profits are correspondingly small and may be estimated at about Rs. 50 per acre at the present price of Rs. 1.75 per lb. The Department of Agriculture has, however, been alive to the need for investigational work on the crop in order to advise cultivators on the best varieties and types of grasses to be grown and on the benefits of manuring and other cultural practices. This issue of " *The Tropical Agriculturist* " contains two useful articles detailing the results of investigations carried out over a period of five years at two of our experiment stations, viz., Mapalana and Embilipitiya. It has been conclusively demonstrated that, irrespective of the variety cultivated, yields of oil can even be trebled by judicious manuring with artificials. The trials have also shown that if citronella is adequately manured, high yields of oil could be maintained over a period of years. This is contrary to the general experience on our unmanured citronella plantations where yields of oil decline appreciably after the second year of cultivation. It is also clear that the less-hardy *maha pangiri* variety could advantageously be cultivated on the poor lateritic soils of the citronella district if liberal manuring is adopted. The optimum time of cutting of the grass has also been investigated and it has been shown that a four-month cutting interval is about the optimum at both places. Further trials are to be conducted by the Department with imported planting material of the *maha pangiri* type from Java as well as with local *lena batu* strains reputed to give high yields of oil.

Citronella oil is obtained by steam distillation in stills which though superior to those in South India are not as advanced as some of those in Java. Preliminary investigations carried out by the Department of Industries into distillation practices have indicated that the efficiency of oil extraction is very low and that with suitable modifications a considerable improvement in oil yield can be effected.

The average export of citronella oil from the Island is about 650 tons per annum. Pre-war, Ceylon took second place to Java in regard to the trade in this commodity. The position has altered very appreciably since then, Formosa and Guatamala being now the largest producers of the oil. The price of the oil has varied appreciably over the years from less than a rupee to over Rs. 6 per lb. The latter price which was reached in 1951 has now dropped to about Rs. 1.75 per lb. The U. S. A., U. K., Holland and Japan are the largest purchasers of the oil, but the U. K. and the U. S. A. are our principal markets.

Two qualities of Ceylon citronella oil are recognized by the trade. They are known respectively as " estate " or " superior " oil, which is sold on the basis of a minimum geraniol content of 60 per cent. and " ordinary " or " f.a.q." oil. The latter forms about 90 per cent. of the total exports from the Island. Unfortunately much of the Ceylon citronella oil exported is adulterated with kerosene in amounts varying up to about 10 per cent. This is because the " ordinary " oil is sold on a solubility test known as the Schimmel's Test which permits of such adulteration. The problem of preventing this practice and of promoting the export of pure oils has engaged the attention of the authorities for many years, but as purchasers abroad are not unaware of the prevalence of adulteration and accept oils of this quality, no deterrent steps have been taken up to now. However, a committee appointed by the Minister of Commerce to determine export quality standards for citronella oil are now engaged in considering the matter with particular reference to the introduction of a system of certification relative to the export of the product. The question has also recently been examined by an inter-departmental committee appointed by Government to consider the question of the improvement of the citronella industry of the Island generally. It is likely that before any final decisions are taken in regard to the question of certification, steps would be taken to obtain, over a sufficiently long period, data on the analytical quality of samples drawn from every consignment of citronella oil exported from the Island. Until such time as this information becomes available, it may be inadvisable to interfere with the present operation of a long-established trade. Producers of Ceylon citronella oil and purchasers as well should, however, realize that ultimately it would be to their mutual benefit if a trade could be established in *pure* citronella oil, whatever be the intrinsic quality of the local oil produced.

Government is aware of the economic importance of this industry in the underdeveloped areas of South East Ceylon and will endeavour to do whatever it could to improve the standards of the industry. The appointment of an inter-departmental committee to study and report on all aspects of the industry is an indication of its anxiety to see that Ceylon citronella oil is placed on a sound economic footing in the interests both of the producers and of the Island as a whole.

Investigations on the Cultivation of Citronella in Ceylon

A. W. R. JOACHIM AND D. G. PANDITTESEKERA

I.—The Effects of Organic and Artificial Fertilizers on the Yield of Grass and Oil

INVESTIGATIONS on factors that can contribute to the improvement of citronella yields in Ceylon commenced at Mapalana in the Matara District in 1939. The effects of organic manure and artificial fertilizers on the yield of grass and oil were studied over a period of six years with *Cymbopogon winterianus* Jowitt, locally named *Mahapangiri*, and *Cymbopogon nardus* Rendle known as *Lenabatu-pangiri*. Of the two species *Cymbopogon nardus* is more commonly cultivated in Ceylon.

Material and Methods

Planting material of the two species was obtained from the Agricultural Station, Labuduwa, Galle, where these had been grown separate for a few years. Planting was done in the *maha* (north-east monsoon) season of 1939, between the twelfth and twenty-third of October. The land was ploughed and harrowed in the usual way. No application of organic manure or artificial fertilizer was made. The land was gently undulating and the soil was a typical lateritic gravelly loam.

Four blocks, each measuring 30 feet by 144 feet, were demarcated. Each block accommodated six plots; the plot dimensions were 30 feet by 24 feet. The long side of each plot was in

Table 1—Monthly Rainfall in Inches at Mapalana during the Period 1939 to 1945

	1939	*1940*	*1941*	*1942*	*1943*	*1944*	*1945*
January	1·46	0·79	1·52	5·69	1·98	5·52	0·40
February	1·22	1·20	1·31	1·44	2·48	10·11	0·69
March	1·46	5·67	2·88	6·50	7·50	6·67	11·29
April	14·77	3·47	8·10	18·67	4·95	7·66	5·84
May	11·51	18·07	17·04	11·40	23·89	25·22	5·32
June	6·62	9·16	8·46	9·71	8·72	7·46	11·11
July	3·41	2·17	8·47	5·31	2·75	3·43	5·24
August	7·89	8·13	8·86	5·17	3·77	6·33	2·67
September	5·10	4·96	16·65	7·07	1·54	10·89	4·60
October	13·46	12·16	13·46	18·14	7·70	15·37	11·50
November	12·67	13·61	13·78	6·84	14·98	14·05	12·97
December	8·91	9·49	0·52	13·35	7·46	5·37	1·79
Total	88·48	88·88	101·05	109·29	87·72	118·08	73·42

the direction of the fertility gradient, viz., along the slope of the land. The three fertilizer treatments, combined with the two varieties, gave six treatments in all, which were randomly assigned to the six plots in each block. The design of the experiment was therefore a randomised block with four replicates. The varieties were planted in their respective plots at a spacing of two feet by two feet, in *quincunx* fashion, with three shoots per hill. The rainfall distribution (Table 1) was favourable at the time of planting, with 13.5 inches in October, 12.7 in November, and 8.9 in December. A period of drought followed in January and February. Vacancies occurred and these were supplied in June, 1940. *Cymbopogon confertiflorus* Stapf. (*Mana*) was observed as an impurity in the plots in December, 1940; these rogue plants were removed and vacancies supplied.

Harvests

The first harvest was made on June 26, 1940, that is, eight months after planting. All plots were cut and the fresh weight of grass in each plot was determined. A border of two feet was discarded around each plot and yield records were confined to a plot size of 26 feet by 20 feet.

Harvests were repeated at intervals of three months; the annual yield of each plot was the total of four harvests. Comparisons between treatments were accordingly made on aggregate values of harvests over a complete year, except in the instance of the first harvest, which measured the yield over the first eight months from the date of planting.

Manuring

Manuring commenced immediately after the fifth harvest in June, 1941, and was repeated after every harvest for four successive years. The treatments were—

(1) No manure.
(2) Nitrogen alone.
(3) Nitrogen, phosphate, and potash.

These were supplied as follows:—

(1) No manure (control).
(2) 168 lb. Calcium cyanamide (32 lb. N) per acre per year.
(3) 168 lb. Calcium cyanamide (32 lb. N), 127 lb. basic slag (24 lb. P_2O_5), and 42 lb. muriate of potash (21 lb. K_2O), per acre per year.

In the second year of manuring, commencing June, 1942, groundnut cake was substituted for calcium cyanamide, and saphos phosphate for basic slag, owing to the unavailability of these fertilizers. The quantities of nitrogen and phosphoric acid per acre were maintained, and accordingly the plots received the following treatments:—

(1) No manure.
(2) 504 lb. groundnut cake (35 lb. N) per acre.
(3) 504 lb. groundnut cake (35 lb. N), 84 lb. saphos phosphate (25 lb. P_2O_5), and 42 lb. muriate of potash (21 lb. K_2O), per acre per year.

In the third and fourth years of manuring, a further change in the manurial treatments was considered desirable, and compost with citronella ash was used in

treatment (2). In treatment (3) the quantity of nitrogen was reduced and potash increased. The three treatments were then:

(1) no manure;

(2) 3 tons compost (33 lb. N; 13 lb. P_2O_5; 20 lb. K_2O) per acre with 3 cwt. citronella ash (24 lb. K_2O) per acre;

(3) 336 lb. groundnut cake (24 lb. N), 84 lb. saphos phosphate (25 lb. P_2O_5), and 84 lb. muriate of potash (42 lb. K_2O) per acre per year.

The treatments specified above were applied to the same plots throughout, following the original randomisation of treatments in each block. The total quantity of fertilizer per acre was divided into four equal doses and applied after each harvest.

Results

The yields of *Mahapangiri* and *Lenabatu* and the response to fertilizer applications were determined in terms of weight of grass and of oil. The yield figures of fresh weight of grass are considered first, and are presented in Table 2. Each of the six treatment yields in a block is the total of four harvests in each year; in the first eight months, however, only one harvest was made. Block totals and treatment totals of each year are shown in the table. Separate analyses of variance were done for each of the six years' data and these are presented in Tables 3—8. A summary of yields accompanies each analysis of variance table.

It will be observed that no fertilizers were applied in the first two years, and treatment differences are accordingly only in respect of the two species of citronella, which are hereafter referred to as varieties for convenience. The analyses of variance of the first and second year were done on eight values. Each value is the variety total of three plots in each block. In each of these two years, *Lenabatu* gave a slightly higher yield over *Mahapangiri*, but the difference in yield between these two varieties did not reach the five per cent. level of significance (Tables 3 and 4).

With the application of fertilizers at the end of the second year, there was a striking increase in yield in plots treated with the complete mixture of nitrogen, phosphate, and potash. Plots treated with nitrogen alone gave yields equal to those with no fertilizer. The analysis of variance given in Table 5 shows fertilizer treatments differing significantly at the 0.1 per cent. point of probability. The yield obtained with the complete mixture of NPK was nearly twice that of plots with nitrogen alone.

The results of the fourth year, that is, the second year of manuring, were similar to those of the previous year (Table 6). Fertilizer treatments differed significantly at the 0.1 per cent. point. The NPK plots gave twice the yield of the nitrogen plots. The nitrogen plots gave a yield slightly higher than those of the unmanured control, but again the difference between these was not significant.

In the absence of a response to nitrogen alone, this fertilizer treatment was replaced by compost with citronella ash in the fifth and sixth years. The results of the fifth and sixth years are presented in Tables 7 and 8. Significance at the 0.1 per cent. point was obtained for fertilizer treatments as a whole in each of these years. Plots with the complete NPK mixture of artificial fertilizers significantly outyielded those with compost and ash by fifty per cent. in each of the years. The two fertilizer treatments were significantly superior to the unmanured control.

Table 2—Grass Yields indicating Response of Mahapangiri and Lenabatu to Fertilizers

(Yields are expressed in pounds per plot (26′ × 20′) which is the total of four harvests in each year, except in the instance of the eight months ending June, 1940)

		First Eight Months ending June, 1940 (no fertilizers applied)					*Second Year ending June, 1941 (no fertilizers applied)*					*Third Year ending June, 1942*				
		Blocks					*Blocks*					*Blocks*				
		I	*II*	*III*	*IV*	*Totals*	*I*	*II*	*III*	*IV*	*Totals*	*I*	*II*	*III*	*IV*	*Totals*
MAHAPANGIRI																
Fertilizer treatments	1	100	103	65	54	322	298	228	237	238	1,001	205	213	137	189	744
	2	130	60	85	53	328	358	200	208	216	982	256	186	138	204	784
	3	40	72	136	101	349	256	172	245	270	943	342	317	285	366	1,310
	Totals	270	235	286	208	999	912	600	690	724	2,926	803	716	560	759	2,838
LENABATU																
Fertilizer treatments	1	33	110	112	40	295	286	282	218	229	1,015	150	244	155	167	716
	2	66	195	96	29	386	226	368	211	181	986	161	260	143	155	719
	3	109	54	176	84	423	319	231	310	255	1,115	406	352	257	361	1,376
	Totals	208	359	384	153	1,104	831	881	739	665	3,116	717	856	555	683	2,811
Block Totals		478	594	670	361	2,103	1,743	1,481	1,429	1,389	6,042	1,520	1,572	1,115	1,442	5,649

		Fourth Year ending June, 1943					*Fifth Year ending June, 1944*					*Sixth Year ending June, 1945*					*Total Yield for Six Years*
		Blocks					*Blocks*					*Blocks*					
		I	*II*	*III*	*IV*	*Totals*	*I*	*II*	*III*	*IV*	*Totals*	*I*	*II*	*III*	*IV*	*Totals*	
MAHAPANGIRI																	
Fertilizer treatments	1	214	193	144	142	693	130	120	82	93	425	75	63	53	65	256	3,441
	2	311	188	147	198	844	270	184	151	174	779	183	111	112	116	522	4,239
	3	441	484	418	489	1,832	306	275	275	334	1,190	239	190	221	217	867	6,491
	Totals	966	865	709	829	3,369	706	579	508	601	2,394	497	364	386	398	1,645	14,171
LENABATU																	
Fertilizer treatments	1	135	242	136	145	658	99	165	117	104	485	78	97	86	88	349	3,518
	2	155	350	158	174	837	170	253	244	162	829	124	165	175	104	568	4,325
	3	441	397	386	330	1,554	402	264	253	301	1,220	327	189	194	189	899	6,587
	Totals	731	989	680	649	3,049	671	682	614	567	2,534	529	451	455	381	1,816	14,430
Block Totals		1,697	1,854	1,389	1,478	6,418	1,377	1,261	1,122	1,168	4,928	1,026	815	841	779	3,461	28,601

Table 3—Analysis of Variance and Summary of Yields of the First Eight Months ending June, 1940

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F. value for Significance (5% point)*
Varieties	1	1,378	1,378	0·28	10·13
Blocks	3	27,445	9,148		
Error	3	14,546	4,848		
Total	7	43,369			

Difference between varieties is not significant.

Variety	*Yield of grass in pounds per acre*
Mahapangiri	6,973
Lenabatu	7,706

Table 4—Analysis of Variance and Summary of Yields of the Second Year ending June, 1941

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F. value for Significance (5% point)*
Varieties	1	4,512	4,512	0·32	10·13
Blocks	3	38,165	12,722		
Error	3	41,190	13,730		
Total	7	83,867			

Difference between varieties is not significant.

Variety	*Yield of grass in pounds per acre*
Mahapangiri	20,423
Lenabatu	21,750

Table 5—Analysis of Variance and Summary of Yields of the Third Year ending June, 1942

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F. value for Significance (0·1% point)*
Varieties	1	31	31		
Fertilizers	2	121,018	60,509	46·62 ***	11·34
Variety × Fertilizer	2	1,139	569		
Blocks	3	21,063	7,021		
Error	15	19,481	1,298		
Total	23	162,732			

*** Significant at the 0·1% point.

Treatments	*Yield of grass in pounds per acre*	*Percentage of mean yield*
Mahapangiri	19,809 ..	100·5
Lenabatu	19,621 ..	99·5
Significant difference	2,628 ..	13·3
No manure	15,286 ..	78
Nitrogen alone	15,736 ..	80
Nitrogen, phosphate and potash	28,122 ..	143
Significant difference	3,216 ..	16
Mean yield	19,715 ..	100

Table 6—Analysis of Variance and Summary of Yields of the Fourth Year ending June, 1943

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F. values for Significance at (0·1% point)*
Varieties ..	1 ..	4,267 ..	4,267		
Fertilizers ..	2 ..	298,215 ..	149,107	.. 54·64 ***	.. 11·34
Variety × Fertilizer	2 ..	5,553 ..	2,776		
Blocks ..	3 ..	22,208 ..	7,403		
Error ..	15 ..	40,943 ..	2,729		
Total ..	23	371,186			

*** Significant at the 0·1% point.

Treatments	*Yield of grass in pounds per acre*	*Percentage of Mean yield*
Mahapangiri	23,516 ..	105
Lenabatu	21,282 ..	95
Significant difference	3,804 ..	17
No manure	14,145 ..	63
Nitrogen alone	17,600 ..	79
Nitrogen, phosphate and potash	35,451 ..	158
Significant difference	4,656 ..	20
Mean yield	22,399 ..	100

Table 7—Analysis of Variance and Summary of Yields of the Fifth Year ending June, 1944

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F. value for Significance at (0·1% point)*
Varieties	1	216	216		
Fertilizers	2	140,850	70,425	36·26 ***	11·34
Variety × Fertilizer	2	659	329		
Blocks	3	6,343	2,114		
Error	15	29,127	1,942		
Total	23	177,195			

*** Significant at the 0·1% point.

Treatments	*Yield of grass in pounds per acre*	*Percentage of mean yield*
Mahapangiri	16,710	97
Lenabatu	17,687	103
Significant difference	3,192	19
No manure	9,528	55
Compost and Citronella ash	16,836	98
Groundnut cake, saphos, and muriate of potash	25,233	147
Significant difference	3,928	23
Mean yield	17,199	100

Table 8—Analysis of Variance and Summary of Yields of the Sixth Year ending June, 1945

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F. value for Significance at (0·1% point)*
Varieties	1	1,118	1,118		
Fertilizers	2	85,005	42,502	38·36 ***	11·34
Variety × Fertilizer	2	356	178		
Blocks	3	6,066	2,022		
Error	15	16,621	1,108		
Total	23	109,166			

*** Significant at the 0·1% point.

Treatments	*Yield of grass in pounds per acre*	*Percentage of mean yield*
Mahapangiri	11,482	95
Lenabatu	12,676	105
Significant difference	2,424	20
No manure	6,334	52
Compost and Citronella ash	11,412	94
Groundnut cake, saphos, and muriate of potash	18,490	153
Significant difference	2,960	24
Mean yield	12,079	100

In none of the years did the two varieties differ significantly although *Lenabatu* generally out-yielded *Mahapangiri*.

Curves showing the fertilizer effects on the two varieties are presented in Fig. 1. Table 9 gives yield figures relating to these curves. Considering the unmanured treatments shown in the curves, it is seen that yields are highest in the second year, and thereafter there is a rapid and steady decline, which reaches uneconomical levels at the end of the sixth year. With the complete NPK mixture of artificial fertilizer, spectacular increases in yield were obtained, which reach a maximum in the fourth year. Even in the sixth year the yield of the NPK treatment is as much as the highest yield obtained without manuring, viz., the yield of the unmanured plots in the second year. Curves relating to yield of oil are presented in Fig. 2.

The Extraction and Yield of Oil

The extraction of oil was effected by steam distillation in experimental stills. The oil was wilted in the shade for about a day and then used for distillation.

In the first five harvests, distillation was done in the Chemical Laboratory at Peradeniya. Differences between plots were only in respect of varieties, and therefore a single sample of fresh grass of each of the varieties was drawn from the produce of all plots and blocks. A known weight of each sample (about 100 lb.) was despatched to Peradeniya immediately after wilting. On receipt this grass was weighed and an aliquot taken for distillation. The oil obtained from this sample was dried, measured and weighed. The weights of oil per plot at each cutting were thus obtained.

After the commencement of manuring in 1941, a direct-heating essential oil still of 40-gallon capacity was installed at Mapalana, and this was used for distillation of all samples. Adequate precautions were taken to clean out the still before use and again at the end of each distillation.

The yield of oil, expressed in pounds per acre for each of the treatments, is given in Table 10. A comparison of the total yield of oil obtained over six years in each of the treatments indicates that *Mahapangiri* yielded more oil than *Lenabatu*. Moreover, striking increases in the yield of oil were obtained with application of fertilizers. The plots manured with the complete NPK mixture of artificial fertilizer gave over the four-year manurial period nearly four times the yield of oil of the unmanured plots.

In Table 11, the oil content of the two varieties, expressed as a percentage of the weight of oil on fresh weight of grass, indicates that in general *Mahapangiri* has a higher oil content than *Lenabatu*. This difference appears to even out in subsequent years. It will be observed that figures of percentage oil show a considerable amount of variation from harvest to harvest. This may be related to weather conditions and also to difficulties in recovering the full quantity of oil in each distillation, in spite of precautions taken. The average value of all harvests should however be more reliable. The mean values accordingly appear to indicate that manuring with the complete NPK mixture does at any rate help the grass to maintain its oil content over the years.

In Table 12 the " total gereniol " contents of samples of oil of the two varieties are shown. These figures confirm the superiority of *Mahapangiri* over *Lenabatu* in respect of quality of oil.

On these comparisons of yield and quality of oil of the two varieties, *Mahapangiri* should be the more profitable variety to grow. Manuring with a complete NPK mixture was indeed

the most important method of increasing yields. Moreover, with regular manuring, replanting of citronella grass is not essential, except perhaps at long intervals.

Table 9—Yield of citronella grass in pounds per acre, indicating response of Mahapangiri and Lenabatu to fertilizers

		First Year ending June, 1940	*Second Year ending June, 1941*	*Third Year ending June, 1942*	*Fourth Year ending June, 1943*	*Fifth Year ending June, 1944*	*Sixth Year ending June, 1945*
Mahapangiri A	1.	6743	20983	15581	14513	8900	5361
	2.	6868	20606	16419	17675	16314	10932
	3.	7308	19748	27434	38366	25131	18094
Lenabatu B	1.	6177	21298	14995	13780	10157	7309
	2.	8083	20698	15058	17529	17361	11895
	3.	8858	23392	28817	32544	25550	18806

Table 10—Yield of citronella oil expressed in pounds per acre, indicating response of Mahapangiri and Lenabatu to fertilizers

Fertilizer Treatments		*No Fertilizers*		*Fertilizers Applied*				*Total 3rd-6th Years*	*Total of Six Years*
		First Year ending June, 1940	*Second Year ending June, 1941*	*Third Year ending June, 1942*	*Fourth Year ending June, 1943*	*Fifth Year ending June, 1944*	*Sixth Year ending June, 1945*		
Mahapangiri A	1.	34·34..	112·05..	38·95..	39·16..	31·62..	15·92..	125·65..	272·04
	2.	34·97..	97·38..	69·74..	56·96..	72·67..	49·21..	248·58..	380·93
	3.	37·49..	95·70..	99·06..	162·09..	138·64..	103·66..	503·45..	636·64
Lenabatu B	1.	30·99..	70·75..	48·38..	34·97..	39·16..	21·57..	144·08..	245·82
	2.	40·12..	69·53..	57·59..	56·96..	67·02..	44·82..	226·39..	336·04
	3.	44·19..	78·11..	122·14..	125·03..	115·60..	94·24..	458·01..	580·31

Summary

1. Manuring with a complete artificial fertilizer mixture (NPK) was the most effective method of increasing yields of citronella grass and oil. Grass yields were two to three times those from unmanured plots. The total yield of oil over the four-year manurial period was nearly four times that of the unfertilized treatment.

2. Nitrogen alone did not increase yields. Phosphate and potash were found particularly important in the manuring of citronella.

3. With regular applications of a complete fertilizer mixture, replanting is not essential, except perhaps at long intervals. Even in the sixth year the yield of grass from the plots receiving this treatment was nearly as much as the highest yield obtained without manuring.

4. *Lenabatupangiri* generally outyielded *Mahapangiri* in weight of grass, but the difference did not exceed ten per cent. in any one year. In no instance was this difference statistically significant.

5. Grass of *Mahapangiri* in the early stages showed a higher oil content than that of *Lenabatu*, but with advancing age these differences were evened out.

6. Manuring has a beneficial effect on oil content, optimum results being obtained with the complete fertilizer. This enabled the grass to maintain its original oil content.

7. *Mahapangiri* oil has a higher " total gereniol " content than oil of *Lenabatu*.

8. On comparisons of the yield and quality of oil, *Mahapangiri* is the more profitable variety to grow, if fertilizers are used.

Acknowledgements

The writers express their thanks to the various Divisional Agricultural Officers and Farm Managers who were connected with the Mapalana Station during the period of these trials. They are greatly indebted to Mr. L. H. Fernando for having kindly assembled the data of these trials and presented them in tabular and diagrammatic form, and for other general assistance in the preparation of the paper.

Table 11—Oil content of varieties expressed as a percentage of the weight of oil on the fresh weight of grass

Harvests before manuring	*Lenabatu*	*Mahapangiri*
1st	·50	·51
2nd	·25	·45
3rd	·55	·72
4th	·34	·43
5th	·34	·34
Average	·40	·50

Harvests after manuring	*Lenabatu Fertilizer treatments*			*Mahapangiri Fertilizer treatments*		
	1	2	3	1	2	3
1st	·25	·27	·23	·21	·29	·24
2nd	·26	·43	·53	·35	·47	·54
3rd	·60	·55	·68	·26	·43	·33
4th	·27	·38	·57	·22	·37	·43
5th	·20	·29	·28	·22	·25	·26
6th	·26	·28	·33	·23	·33	·49
7th	·31	·49	·53	·37	·36	·65
8th	·30	·37	·42	·34	·39	·45
9th	·44	·34	·51	·41	·46	·55
10th	·39	·39	·41	·34	·41	·46
11th	·46	·46	·47	·45	·53	·60
12th	·31	·35	·37	·23	·41	·59
13th	·33	·25	·46	·21	·34	·43
14th	·29	·41	·50	·45	·50	·81
15th	·28	·42	·45	·38	·53	·61
16th	·24	·53	·61	·25	·53	·58
Average	·32	·39	·46	·31	·41	·50

Table 12—Gereniol content expressed as a percentage by weight of Citronella oil

Harvests	*Mahapangiri*	*Lenabatu*
1st	70·2	56·7
2nd	73·0	59·9
3rd	69·4	48·2
4th	61·0	56·6
5th	63·1	56·4
6th	70·7	50·6
7th	71·7	52·7
8th	71·3	56·4
9th	71·4	53·6
10th	71·9	52·2
11th	72·2	52·1
12th	72·2	53·0
13th	75·6	54·8
14th	69·7	55·8
15th	69·7	55·9
Mean	70·2	54·3

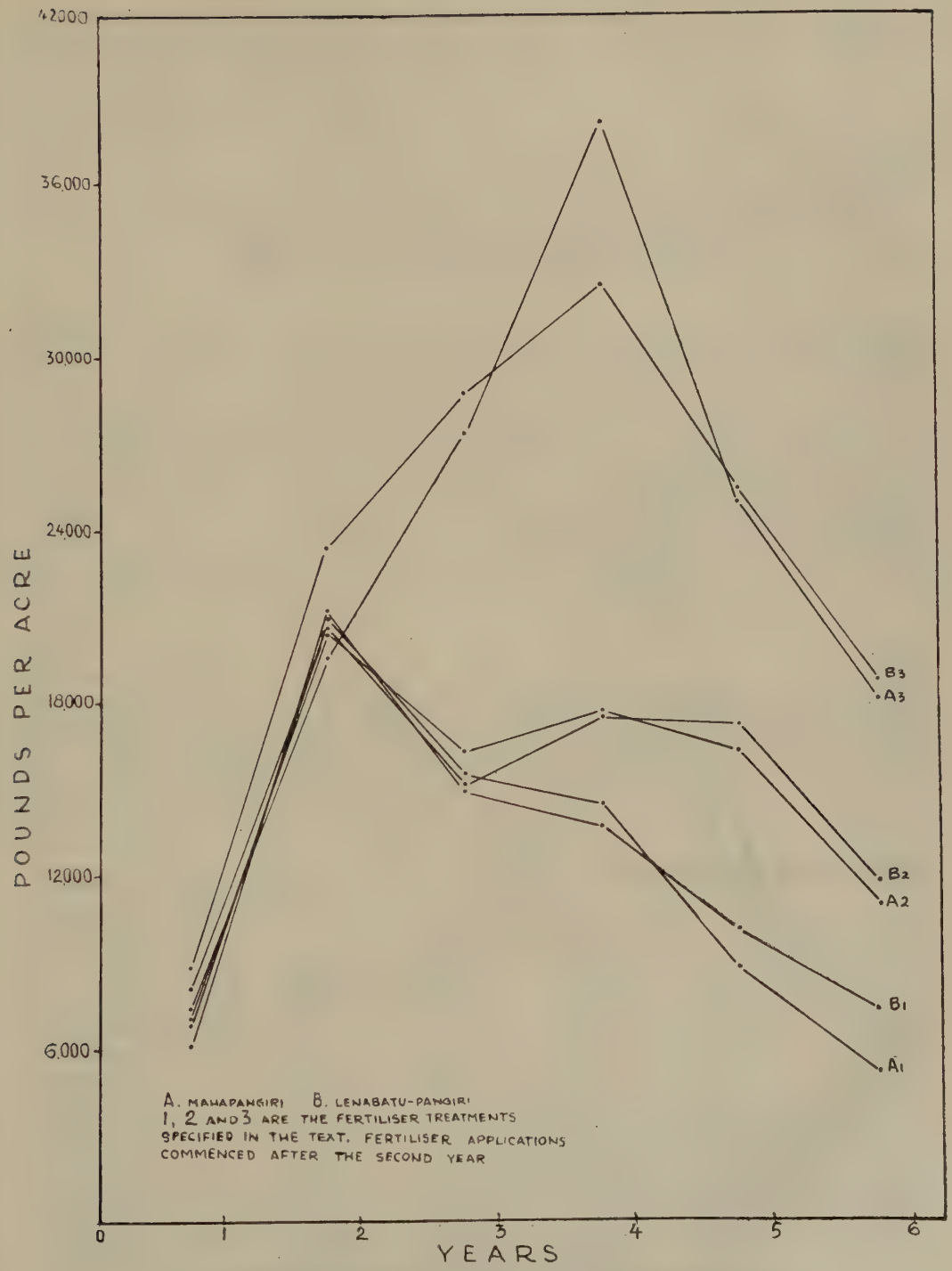

FIG. 1. FERTILISER EFFECTS ON THE YIELD OF CITRONELLA GRASS.

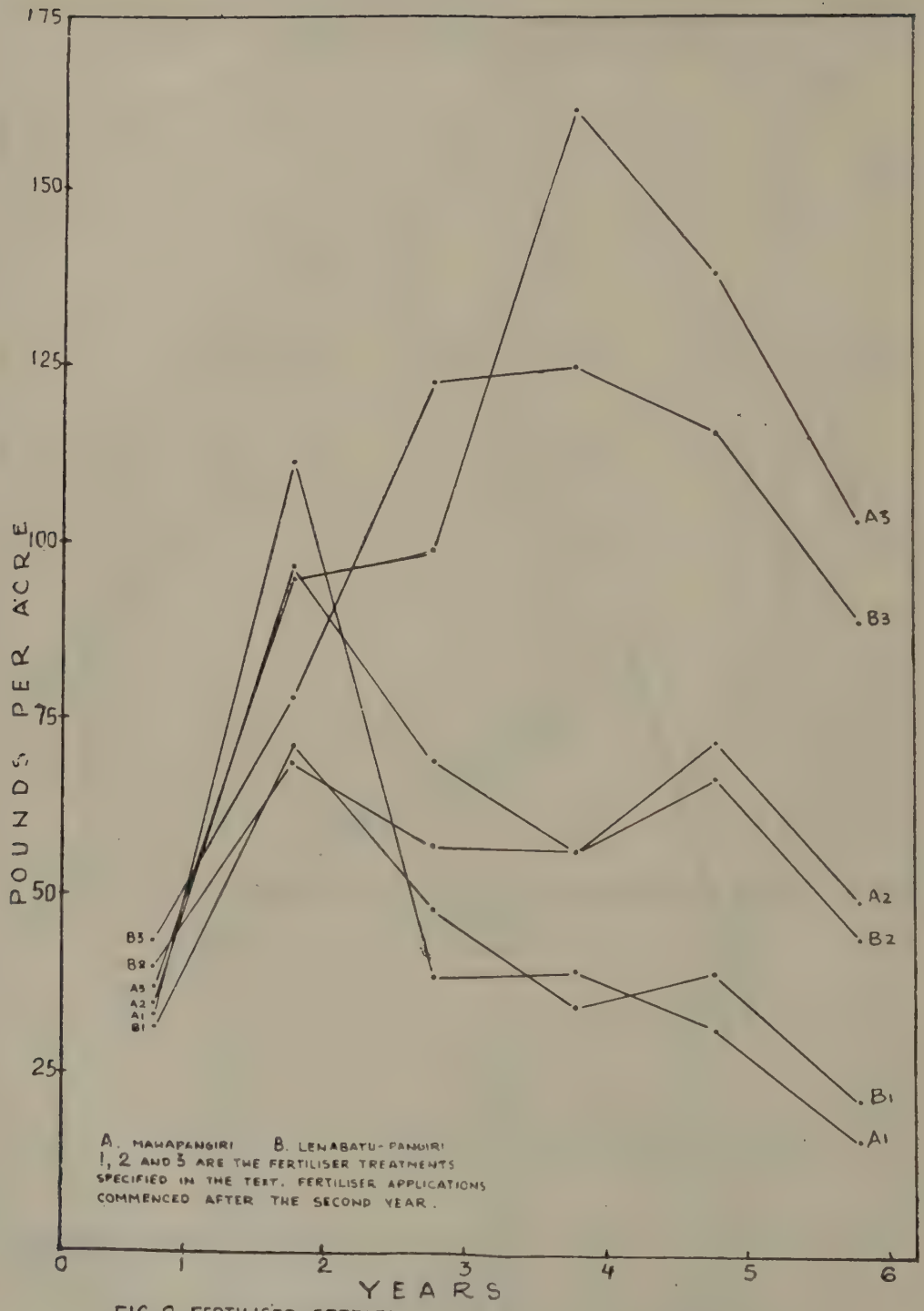

FIG. 2. FERTILISER EFFECTS ON THE YIELD OF CITRONELLA OIL

Investigations on the Cultivation of Citronella in Ceylon

L. H. FERNANDO

II.—The Influence of Variety, Frequency of Harvests, and Manure, on the Yield of Grass at Embilipitiya

THIS experiment followed the earlier investigations of Joachim and Panditteseker a, reported in the first part of this publication. The treatments and design of the present investigation were, in fact, suggested by Dr. A. W. R. Joachim, who initiated work on this subject. The experiment reported herein commenced in November, 1945, and was conducted at the Agricultural Station, Embilipitiya, over the period 1945-1949. The annual rainfall (Table 1) varied between 47 and 64 inches. An attempt was made to explore the possibility of extending citronella cultivation to the semi-dry parts of the Ratnapura District, of which Embilipitiya was representative. The influence of variety, harvesting frequency, and manure, on the yield of grass was studied. No facilities were available for the extraction of oil, and grass yields alone were therefore determined.

Material and Methods

Planting material of the two citronella species *Cymbopogon winterianus* Jowitt (*Mahapangiri*) and *Cymbopogon nardus* Rendle (*Lenabatupangiri*) were obtained from the Agricultural Station, Mapalana. The land was prepared in the usual way, but no manurial dressing was given.

Table 1—Monthly Rainfall in Inches at Embilipitiya during the Period 1945 to 1949

Months	*Years*				
	1945	*1946*	*1947*	*1948*	*1949*
January	0·34	0·67	2·74	5·78	3·41
February	1·88	2·13	0·44	2·59	2·76
March	5·23	5·46	13·87	6·92	0·51
April	4·38	11·46	3·39	5·40	11·22
May	1·80	0·30	7·02	2·44	2·77
June	3·11	2·34	4·41	0·95	2·37
July	0·34	0·31	0·11	0·63	6·79
August	0·25	0·53	6.49	0·50	2·47
September	0·08	2·13	0·75	1·37	1·05
October	8·94	8·63	5·71	12·15	8·19
November	15·22	10·43	6·95	12·60	5·42
December	6·30	12·24	10·32	12·43	4·93
Total	47·87	56·63	62·20	63·76	51·89

The design of the experiment was factorial, 2 × 2 × 2, and the eight treatment combinations were replicated four times, giving 32 plots in all, arranged in eight blocks of four plots each. The second-order interactions were confounded with blocks. The eight treatments were composed of the two varieties, manured and unmanured, combined with two frequencies of harvest, viz., intervals of three months against four months. The plot size was 38 feet by 18 feet, and each block was 38 feet by 72 feet. With the blocks in pairs, the eight treatments were accommodated in a compact rectangular area of 38 feet by 144 feet. A randomised block analysis was thus provided for, if necessary.

Planting was done between the thirteenth and sixteenth of November, 1945. The plants were spaced two feet by two feet, in *quincunx* fashion. Two shoots were planted per hill. Vacancies were considerable and were supplied from time to time.

Harvests

The first harvest was done ten months after planting, that is, in September, 1946. A border of two feet around each plot was discarded, and the fresh weight of grass of an area 34 feet by 14 feet was recorded in each plot. The difference between plots at this stage was only in respect of the two varieties. Thereafter, half the number of plots were harvested at intervals of three months (F_1) and half at intervals of four months (F_2): the F_1 plots, therefore, had four harvests a year, and the F_2 plots three harvests. Comparisons between plots were made on the total yield of harvests over a complete year.

Results

The annual yield of each plot over the four years is shown in Table 2. In the first year, the yield of each variety was given by two of the four plots in each block. The analysis of variance was accordingly done on sixteen values, with fifteen degrees of freedom in all (Table 3).

The error variance was greater than the variety variance, indicating no significant difference in the yields of the two varieties. This was due largely to the irregularity in the stand of plots. With the supplying of vacancies, plots presented a more uniform stand of plants.

In the course of the second year, the effects of variety and harvesting frequency were investigated. Half the number of plots were harvested at intervals of three months and half at intervals of four months. Comparisons of varieties and frequencies of harvest were made on the annual yield of plots. The analysis of variance and summary of results are presented in Table 4.

The two varieties and the two frequencies of harvest differed significantly at the five per cent. point of probability: *Lenabatu* yielded ten per cent. more than *Mahapangiri* ; the four-monthly harvests yielded eight per cent. over the three-monthly harvests.

At the beginning of the third year, that is, after the last harvest of the second year, compost at 4 tons per acre and citronella ash at 240 pounds per acre were applied to the appropriate plots ; half the number of plots were left unmanured. The effects of variety, frequency of harvest, and manure, were investigated in the course of the third year. The analysis of variance and summary of results are presented in Table 5.

There were significant differences between the two frequencies of harvest, and between the manured and the unmanured ; but between the two varieties the yield difference was

Table 2—Annual Yield of Citronella Grass in Pounds per Plot

(Treatment totals relate only to varieties in the first year ; to varieties and harvesting frequency in the second year. Manure and its residual effect is operative only in the third and fourth years respectively.)

	Replicate	Blocks	*Lenabatu*		*Mahapangiri*		Block Totals	Blocks	*Lenabatu*		*Mahapangiri*		Block Totals
			Unmanured 4-monthly Harvests	*Manured* 3-monthly Harvests	*Unmanured* 3-monthly Harvests	*Manured* 4-monthly Harvests			*Unmanured* 3-monthly Harvests	*Manured* 4-monthly Harvests	*Unmanured* 4-monthly Harvests	*Manured* 3-monthly Harvests	
First Year	I	1	61	40	78	52	231	2	90	50	72	73	266
	II	3	54	83	66	108	285	4	93	62	51	70	263
	III	5	69	79	80	38	311	6	89	70	57	47	275
	IV	7	57	58	99	61	276	8	73	90	52	55	270
Treatment Totals				501		582				617		477	
Second Year	I	1	398	267	270	284	1219	2	288	318	289	284	1179
	II	3	316	270	254	275	1115	4	302	330	282	254	1168
	III	5	304	336	344	241	1225	6	361	329	370	289	1349
	IV	7	372	306	268	287	1233	8	348	381	392	327	1448
Treatment Totals			1390	1179	1136	1087			1299	1358	1333	1154	
Third Year	I	1	206	196	167	212	781	2	148	208	188	203	747
	II	3	230	184	184	178	776	4	138	183	125	159	605
	III	5	143	189	143	188	663	6	165	196	174	159	694
	IV	7	172	178	144	161	655	8	136	231	197	154	718
Treatment Totals			751	747	638	739			587	818	684	675	
Fourth Year	I	1	219	145	148	233	745	2	156	221	239	208	824
	II	3	240	189	182	216	827	4	151	217	177	175	720
	III	5	204	204	174	215	797	6	188	209	212	185	794
	IV	7	206	177	143	181	707	8	123	224	238	151	736
Treatment Totals			869	715	647	845			618	871	866	719	

Table 3—Analysis of Variance of Yields of the First Year

	Degrees of Freedom	*Sum of Squares*	*Mean Squares*
Blocks	7	879·22	125·60
Varieties	1	108·78	108·78
Error	7	3,010·47	430·07
Total	15	3,998·47	

SUMMARY OF RESULTS :

	Yield Per Acre (Pounds)	*Percentage of Mean Yield*
Lenabatu	6,394	103
Mahapangiri	6,057	97
Mean	6,223	100

Table 4—Analysis of Variance of Yields of the Second Year

	Degrees of Freedom	*Sum of Squares*	*Mean Squares*	*Variance Ratio*	*F value for Significance* 5%	1%
Blocks	7	20089	2869·85			
Variety	1	8320	8320·00	7·54 *	4·32	8·02
Frequency of harvest	1	5000	5000·00	4·53 *	4·32	8·02
Variety × frequency	1	613	613·00			
Error	21	23168	1103·23			
Total	31	57190				

* Significant at the 5% point.

SUMMARY OF RESULTS :

Treatments	*Yield Per Acre (Pounds)*	*Percentage of Mean Yield*
Lenabatu	29892	105
Mahapangiri	26941	95
Three-monthly harvests	27272	96
Four-monthly harvests	29560	104
Mean	28416	100
Standard error	759	3
Significant difference (5% point)	2239	8

not significant. Yields declined in the third year, and the ten per cent. difference between varieties in the second year was reduced to six per cent. in the third year. Between frequencies of harvest, the difference was twelve per cent. in favour of harvests at intervals of four months. The manured plots yielded twelve per cent. more than the unmanured.

In the fourth year, no manure was applied ; the residual effect of manure applied in the previous year were tested. Differences between varieties and between frequencies of harvests continued to be investigated. The analysis of variance of summary of results are presented in Table 6. The two varieties were equal in yield. The mean yield over all plots was little over that of the third year, but was less than that of the second year. A very significant difference was found between the two frequencies of harvests, harvests at

Table 5—Analysis of Variance of Yields of the Third Year

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F Value for Significance* 5%	1%
Blocks	7	6784	969	2·45	2·58	3·85
Main effects						
Variety	1	872	872	2·20	4·41	8·28
Frequency of harvest	1	3720	3720	9·41**	4·41	8·28
Manure	1	3180	3180	8·05*	4·41	8·28
Interactions						
Variety × Frequency	1	487	487			
Variety × Manure	1	569	569			
Frequency × Manure	1	175	175			
Error	18	7125	395			
	31	22912				

** Significant at 1% point.
* Significant at 5% point.

SUMMARY OF RESULTS :	*Yield Per Acre (Pounds)*	*Percentage of Mean Yield*
Lenabatu	16605	103
Mahapangiri	15650	97
Three-monthly harvests	15141	94
Four-monthly harvests	17114	106
Compost (4 tons/acre and citronella ash (240 lb./acre))	17040	106
No manure	15215	94
Mean	16127	100
Standard error	455	3
Significant difference (5% point)	1350	8

intervals of four months giving an annual yield twenty-four per cent. over the three-monthly harvests. The residual effect of manure was four per cent. over the control, but this difference was not significant.

Discussion

The results of this investigation confirm those of Joachim and Panditteseker a. *Lenabatu-pangiri* yielded more grass than *Mahapangiri ;* the difference in yield, however, did not exceed ten per cent., and was statistically significant only in the second year. Yields were highest in the second year and thereafter there was a sharp decline (Fig. 1). Manuring with compost and citronella ash in the third year effected a twelve per cent. increase in yield. The residual effect of this manure in the fourth year was small. Regular and frequent dressings of manure, commencing earlier than the third year, are likely to be more effective. Harvests at intervals of four months were, throughout, significantly better than three-monthly harvests. The unpublished findings of Joachim and Panditteseker a on harvesting frequency (Table 7) are of interest. These workers compared harvests at two, three, and four months intervals at Mapalana. Harvests every two months were found too frequent and yielded less than three- and four-monthly harvests. In contrast to the results at Embilipitiya, there was no striking difference between harvesting intervals of three and four months at Mapalana ; this may be related to the higher rainfall at Mapalana. Although the rainfall at Embilipitiya was less, yields were as high as those obtained at Mapalana.

Acknowledgement

Several officers of the Department of Agriculture, particularly those who were resident on the Embilipitiya Station, gave considerable assistance in the conduct of this experiment. Officers of the Division of Botany, Peradeniya, helped in the preparation of the paper. Though not mentioned individually, I am extremely grateful to each of them.

Table 6—Analysis of Variance of Yields of the Fourth Year

	Degrees of Freedom	*Sum of Squares*	*Mean Square*	*Variance Ratio*	*F Value for Significance* 5%	1%	0·1%
Blocks	7	3927	561				
Main effects							
Variety	1	0	0				
Frequency of harvest	1	17672	17672	40·90***	4·41	8·28	15·38
Manure	1	703	703				
Interactions							
Variety × Frequency	1	120	120				
Variety × Manure	1	72	72				
Frequency × Manure	1	1104	1104	2·55			
Error	18	7787	432				
	31	31385					

*** Significant at 0·1% point.

SUMMARY OF RESULTS:	*Yield Per Acre (Pounds)*	*Percentage of Mean Yield*
Lenabatu	17577	100
Mahapangiri	17600	100
Three-monthly harvests	15438	88
Four-monthly harvests	19739	112
Residual effect of manure	18017	102
No manure	17160	98
Mean	17589	100
Standard error	475	3
Significant difference (5% point)	1411	8

Table 7—The Effects of Harvesting Frequency on the Yield of Citronella Grass at Mapalana (Joachim and Panditteseker a)

	Frequency of Harvest	*Yield of Grass in Pounds per Acre* *First Year*	*Second Year*	*Third Year*
Mahapangiri	2 months	22165	11594	6217
	3 months	21416	19149	11984
	4 months	22369	20146	11389
Lenabatu	2 months	19511	12843	7395
	3 months	24865	22733	12932
	4 months	17016	21009	12025

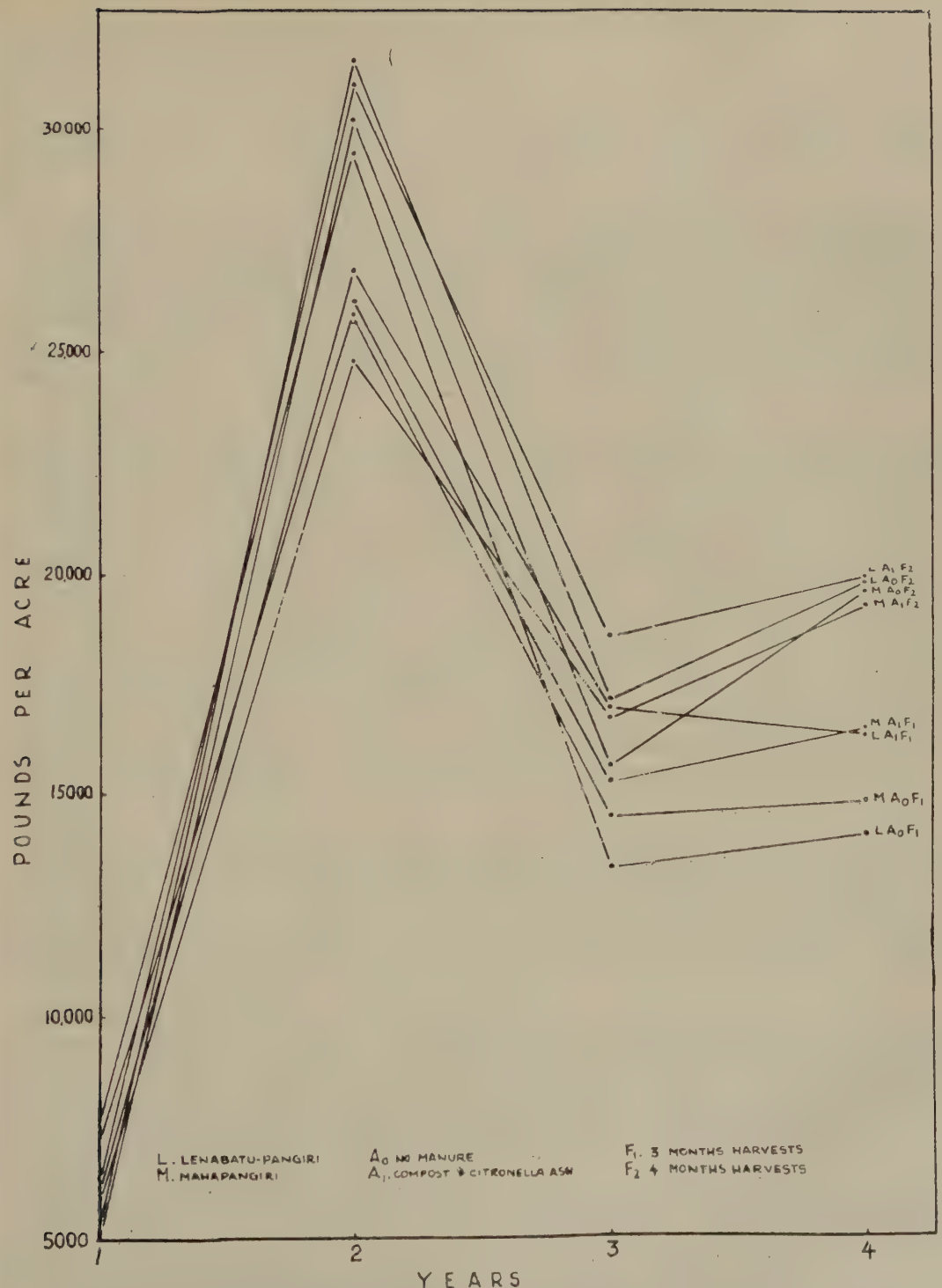

FIG. 1. THE EFFECTS OF FREQUENCY OF HARVESTS AND MANURE ON THE YIELD OF GRASS OF LENABATU AND MAHAPANGIRI AT EMBILIPITIYA

Chilli Leaf Curl Complex

J. W. L. PEIRIS

THE leaf curl of chilli in greater or lesser degree is now known to occur in all parts of the Island wherever chilli is grown. It is of special importance in the Jaffna Peninsula and in the Dry Zone areas where extensive cultivation of chilli continues to be carried out. The damage caused by leaf curl has in recent years been so acute that repeated set-back to this crop in certain areas has caused considerable discouragement to cultivators, who state that now they are getting only a fraction of the yield per acre obtained ten or fifteen years ago.

The subject of chilli leaf curl has received considerable attention in the past. Early observers realized that chilli leaf curl was not always characterized by one rigid set of symptoms but that the symptoms varied in different cases, and that the chilli leaf curl complex consisted of a variety of malformations probably due to viruses. Park and Fernando (1938) questioned the virus nature of the leaf curl complex when they observed certain cases of affected plants showing definite recovery. They showed that certain chilli plants characterized by abaxial curling of leaves recovered when treated with a nicotine sulphate spray. Paul and Fernando (1939) also investigated an adaxial type of leaf curl on chilli different to the above, and came to the conclusion that deficiency of nitrogen or farm-yard manures in the soil could be eliminated as possible causes of this leaf curl of chilli. The distribution of the affected plants suggested the possibility of insects being the cause either directly or as vectors of disease. Johnpulle (1939) carried out infection experiments with mites, aphids, and thrips, and found that thrips were successful in causing a crinkling on the leaves of healthy chilli plants.

The possibility that mites are associated with leaf malformation of chilli came under the observation of the Division of Plant Pathology when a similar leaf curl of Tomato characterized by abaxial curling and reduction of leaves, bronzing, and killing of the apical meristem, was investigated. The malformation was found to be caused by mites, and similar mites were capable of causing leaf curl symptoms on chilli and on a variety of other plants. (PEIRIS 1944).

In further infection experiments on chilli, three-week old healthy plants were inoculated with mites from naturally infected chilli plants found at Peradeniya. Within a period of six days very definite symptoms of downward (abaxial) curving of leaves was found on the inoculated plants. The leaves became " glassy " on the lower surface, and reduction of the younger leaves was observed. Uninoculated control plants remained healthy. When five of the affected plants were sprayed at weekly intervals with a spray of sulfinette (lime-sulphur) at 1 oz./gallon, the affected plants were observed to put out healthy flush. Peiris (1944) also records that the mites infesting chilli could cause leaf curl in Tomato. An identical type of leaf curl of chilli caused by mites has been described by Kulkarni (1922) from India, and the disease there is referred to as " murda " disease of chilli.

Similar experiments with thrips collected from chilli plants showing an adaxial type of leaf curl confirmed Johnpulle's finding that thrips were capable of inducing a leaf

malformation. In this case however, the general tendency of the leaves was to curve upwards (adaxial). Spraying affected plants with nicotine sulphate 1 oz./gallon brought about recovery of the plants, and the new flush was normal. Cherian (1936) reported a leaf curl of chilli in India as being caused by a species of thrips, *Scirtothrips dorsalis* Hood. The leaf curl described here as being caused by thrips is similar to that reported by Cherian but the identity of the local species of thrips is uncertain.

Yet another type of leaf curl of chilli that was normally found around Peradeniya was characterized by an upward curving of the leaf blade similar to the leaf curl caused by thrips, but differing from it in the fact that invariably some of the secondary or minor veins are " cleared " of chlorophyll. This can be best seen when the leaves are held against the light. No insects could be found associated with this leaf curl and it was suspected to be due to a virus. Attempts made to transmit this malformation by inoculation of sap from crushed diseased leaves and rubbing them on the leaves of healthy chilli plants were unsuccessful. The virus was however successfully transmitted by grafting diseased scions to healthy chilli stocks. (PEIRIS 1952.) Of five such grafts made, three successful unions were obtained, and in all these cases the virus was transmitted to the healthy plants which gave characteristic " vein clearing " and an upward curving of leaves in the new flush. The period of incubation was 18—20 days. This malformation has been tentatively designated vein clearing leaf curl of chilli. Its correct identity can only be determined when its relationship to other hosts has been studied. The vector of this virus has been found to be a species of whitefly. (H. E. Fernando ; 1953. Unpublished.)

Recently a further type of malformation of the chilli leaf curl complex came under observation in recent trials at Jaffna. This malformation appears to cause much less alteration of the shape of the leaf than the three types previously mentioned. The leaves may or may not be reduced but infected plants show a characteristic irregular mottle on the leaves, consisting of yellow green and dark green areas. Recently W. Newton (unpublished) has shown that there are two types of mottling due to two different viruses. The first of these only causes the mottle symptom and is easily sap transmissible to healthy chilli plants. The period of incubation was eight days and it is also transmissible to tobacco. It is considered to be a strain of tobacco mosaic virus.

The second type of mottling which is far more prevalent shows a greater tendency to leaf distortion, especially a constriction of leaf tips. It is sap transmissible with difficulty to healthy chilli and its incubation period of fifteen days and its inability to infect tobacco suggests that it is a different virus to the tobacco mosaic strain. An insect vector of the mottle leaf virus of chilli has been established to be *Aphis* sp. (H. E. Fernando, unpublished.)

The evidence so far available has indicated that the chilli leaf curl complex could be resolved into five components, each one of which is caused by a different causal agent, viz.—

(1) Leaf curl caused by mites.
(2) Leaf curl caused by thrips.
(3) Leaf curl caused by vein clearing virus.
(4) Mottle leaf caused by chilli mottle virus.
(5) Mottle leaf caused by tobacco mosaic virus.

The symptom pictures caused by these causal agents can be distinguished reasonably clearly when a plant is infected by one of these agents at a time. In the field however it is sometimes found that one plant is infected by more than one causal agent eventually modifying the symptoms and making an accurate diagnosis more difficult. A correct

diagnosis of the types of leaf curl present is, however, very necessary for the adoption of adequate control measures in any locality, and the following brief description of the different types of leaf curl would prove useful in cases where the symptoms are not complicated by more than one factor or modified by environment.

Leaf Curl caused by Mites

Plants stunted, leaves generally curved downwards (adaxially), specially the earlier infected leaves giving an " inverted spoon " appearance. Often there is a partial suppression of lamina near the petiolar end. Later attacked young leaves are reduced and all affected leaves show a shiny bronze colour as if a coat of varnish has been applied, specially on the lower surface. Affected leaves are brittle, narrowed and thickened. In advanced cases apical meristem is killed and the apex dries up. Axillary bud development is arrested, often producing clusters of minute thickened leaves. In recently attacked leaves, minute mites may be seen crawling on the surfaces when viewed with a hand lens, but are too small to be seen with the naked eye. This is the commonest type of leaf curl on chilli in Ceylon.

Leaf Curl caused by Thrips

Affected plants stunted. Leaves generally curved upwards (adaxially), presenting a " boat shaped " appearance. Leaf margins however may or may not be curled downwards along the edge of the lamina. There is a certain amount of interveinal buckling and the upper epidermis shows signs of irregular scraping by the insect obliterating the normal gloss that is found on healthy leaves. No change in colour is observed in this type of leaf curl.

Leaf Curl caused by Vein Clearing Virus

Plants stunted and internodes shortened, giving a bushy appearance to the plants ; leaves slightly paler in appearance and smaller than healthy leaves. There is an upward (adaxial) rolling of leaves, producing a " boat shaped " effect similar to that caused by thrips. The main characteristic is the clearing of veins, specially the minor ones. This can be easily seen if leaves are held against the light when the cleared veins are observed to be transparent. Sometimes the marginal and interveinal areas of the leaf are paler than the rest of the lamina, and buckling of the leaf may be present.

Mottle Leaf caused by Chilli Mottle Virus

Plants are slightly stunted. Leaves show a light green and dark green mottle and there is a tendency to distortion, especially at the leaf tips. Sometimes there is a buckling of certain areas of the lamina.

Mottle Leaf caused by Tobacco Mosaic Virus

This type of leaf curl perhaps causes the least malformation on the chilli plant as compared with the other types mentioned above. The stunting of the plant and reduction of leaves are slight. The most important feature is a diffused mottle of light green and dark green areas on the leaf. The mottle areas do not bear any definite relation to the veins and are irregularly scattered.

Control

Leaf curl caused by mites has been controlled in the above investigations by using a lime sulphur spray (sulfinette 1 oz./gallon). It is necessary, however, to detect the malformation as early as possible and carry out control measures. If the plants have suffered a considerable set-back in growth it is doubtful whether chemical control would sufficiently revive the plants to make them profitable.

Thrips have been effectively controlled by nicotine sulphate sprays (1 oz./gallon). In preliminary spraying trials on the control of chilli carried out by the Entomologist, however, DDT and more especially Toxaphene proved very promising in the control of leaf curl caused by mites and thrips, and further testing of the modern insecticides would no doubt enable even better control of these two causal agents.

Leaf curl caused by mites and thrips is due to the mechanical damage they cause by feeding on the plants. Once the insects are eliminated by insecticidal sprays the later growths become normal. The leaf curl types caused by the three virus diseases however are unfortunately not so easily amenable to treatment with sprays. Once the vector transmits the disease by feeding for a short time on the plant, the virus becomes systemic ; and even if the vector is subsequently killed, the virus spreads throughout the plant and causes the damage. General spraying of the crop is bound to reduce the vector population but it is doubtful whether this alone is going to be sufficiently effective in controlling these virus diseases owing to the presence of abundant alternate hosts available to the vectors in the form of weeds and other solanaceous plants. The accepted control measures for most virus diseases therefore have to be thoroughly carried out in order to control the vein clearing virus and the mottle leaf diseases of chilli. These consist in early detection and elimination of virus-infected plants and the vigorous suppression of weeds within the chilli crop and to a considerable distance surrounding it. Other solanaceous crop plants like tomato, brinjal, tobacco, &c., may also possibly harbour viruses common to chilli, and also need to be watched.

Tobacco mosaic virus is easily transmissible by sap and the virus could be easily carried on the hands of the cultivator tending these plants and then pass on to chilli. Wherever the presence of tobacco mosaic is known, special attention should be paid to the thorough washing of the hands before handling healthy chilli plants.

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PLATE 1.—Leaf curl of chilli caused by thrips

PLATE 2.—Mottle leaf caused by Tobacco Mosaic virus

PLATE 3.—Leaf curl of chilli caused by mites

PLATE 4.—Leaf curl of chilli caused by vein clearing virus
(Inset) Vein cleared leaf

Some Possible Uses for Soil Fumigation in Ceylon

WALTER CARTER F. A. O.

Introduction

SOIL fumigation as an aid to the production of agricultural crops on a field scale is a relatively recent development. This development, however, has been very rapid in the United States and, to a lesser degree, in other parts of the world.

The effects of soil fumigation are not by any means at all well understood. If any eelworms or nematodes are present in the soil it is evident that the soil fumigant must be nemocidal. However, the effects of soil fumigation in improving growth cannot be entirely ascribed to the killing of nematodes and other harmful organisms in the soil. There is quite definite evidence of root stimulation immediately after plants are planted as vegetative planting pieces, or immediately after germination in the case of seed plantings. There is also positive evidence that soil fumigation results in the depression of the micro-organisms in the soil that are known as nitrifying organisms. The action of these organisms is to convert ammonium nitrogen in the soil to nitrate, and if the organisms are eliminated the ammonium is available for use by the plant directly. For many plants this is an advantage. The gross effect of the soil fumigation must obviously be that of profound modification of the whole micro-flora of the soil in a favourable direction for plant growth.

Nursery Fumigation

The possible use of soil fumigation in Ceylon will, of course, be conditioned by the economics of crop production ; but in view of the fact that many crops in Ceylon are first planted in nurseries, it would seem that here, at least, is one place where soil fumigation should be experimented with, with a view to producing better rooted and more vigorously growing seedling plants. Where special clone material is reproduced vegetatively, such as selected tea clones and vegetatively reproduced cocoa, the fumigation of the soil in which these cuttings are set should result in growth stimulation as well as protection from nematode infestation. Since, in the case of nursery beds, the area to be treated is very small comparatively, the operation should not be costly. It has been demonstrated in the Entomological Division of the Department of Agriculture at Peradeniya that chilli nursery beds treated with soil fumigation before the seed was planted produced chilli seedlings at least twice the size and of very much greater vigour than the untreated controls.

Fumigants and their Rates of Application

The materials available for use as soil fumigants are many, but in modern practice only three are of significance. One is D-D mixture which is used for large areas as a pre-planting fumigant in pineapple, tobacco, sugar beet, and truck crop soils. Ethylene dibromide used for the same purpose is not always as effective as D-D ; but when it is, is actually

considerably cheaper. Ethylene cholorobromide is the most recent material to be used on a field scale but this compound is probably more valuable when treatment of the soil round living plants is desired. The dosages normally used vary within a narrow range. For D-D mixture, from 200-400 pounds per acre is adequate for nematode control and produces definite growth response effects at these doses. The two bromide compounds have to be diluted before use. The common dilution is to use 10 per cent. of the compound, using a light Diesel oil as a diluent. A total of 40 gallons of the diluted material is then applied per acre, resulting in an actual application of the toxicant of 4 gallons per acre. If every sq. ft. of soil is treated, an application rate of 1.8 ccs. to each sq. ft. is roughly the equivalent of 200 lb. or 20 gallons per acre.

When nursery beds are being fumigated it will be advisable to distribute the material evenly and an injection every sq. ft. of soil should provide adequate distribution.

Apparatus

The application of soil fumigants on a field scale presents some very real engineering problems, but for small-scale use in nursery beds the most effective piece of equipment for the application of fumigants is the Fumigun (obtainable in Ceylon through Mackwoods Limited). The Fumigun is a very well built and practical instrument and can be highly recommended. It does require care, however, and if the manufacturers' precautions are followed, this instrument will give very hard service over a long time. For very small growers who have only a few sq. feet to be treated, a hole made with a stick, 6 or 8 inches deep, could have the fumigant dropped into it with a medicine dropper or even a very small spoon. In this case, the doses used would probably be excessive for the very small area treated.

Conclusion

No deleterious effects on the soil have been observed following repeated applications of these fumigants and there has been no change in the physical structure of the soil which could be ascribed to the use of these materials.

It would be extremely useful to Ceylon agriculture if this technique could be experimented with on agricultural crops in Ceylon. With the results obtained as a basis, it might then be possible to extend the use of soil fumigants to field crops or to spot treatment of the small sections of soil in which supplies are planted. On the basis of spot treatment the total quantity of material per acre is not excessive. When fumigants are applied in the field, the soil should be in a good friable condition to permit the dispersal of the vapours through the soil. Rooted plants should not be planted in fumigated soil for a period of at least 10 days after treatment, and longer than that would not be a disadvantage. The same holds for seed plantings. Operators should be cautioned about spilling these materials on their skin, and washing with considerable quantities of soap and water should follow any accidental spillage that may occur.

Further inquiries should be addressed to Plant Pathologist, Peradeniya.

Goat Paralysis

C. PERUMAL PILLAI

Symptoms

THE condition commonly called "Goat Paralysis" in Ceylon is now called Epizootic Cerebro-Spinal Nematodiasis by INNES, Shoho and Pillai (*vide* Brit. Vet. J., March, 1952). In Ceylon, this disease of goats is characterized by motor weakness and posterior inco-ordination. In some goats, there is swaying and stumbling, while in more severe cases there is complete loss of motor power in the hind limbs or of all four legs. The onset is sometimes dramatically sudden ; and a goat might be found lying on its side unable to rise. Some might show nystagmus. The disease is non-febrile. some animals die in a few days, but many survive and then might show clinical improvement but with impaired limb mobility ; yet in other cases, the onset is insidious and the first sign is unsteadiness of the hind limbs which might not be progressive. Every case seen in Ceylon is confined to imported breeds (from India) such as Jamnaparis, Scindhis, Kamoris, Alandis and Saanan (from Australia) and the cross-breeds of them. Local breeds do not suffer from the malady. The disease has no epizootic trend in the Island except in Government farms where large numbers of imported goats are kept.

History of Discovery of Causal Agent

In Ceylon, much preliminary work to elucidate the causal agent of this condition was done by Mahamooth and Crawford since 1938, but the work had to be suspended due to the outbreak of rinderpest during the war years. After the eradication of rinderpest in 1946, attention was again focussed on this disease and it was not until 1949 that work was taken up by the writer. Dr. J. R. M. INNES, presently Chief of Pathology, Army Medical Centre, Maryland, U. S. A., was contacted in 1950 to help study the histopathology of the brain and spinal cord of affected animals. The results of this study were published by INNES (*vide* Brit. Vet. J., May, 1951). During the absence of the writer from the Island, Professor McGaughy of the Ceylon University continued studies on this disease, and acting on the advice of INNES he actually demonstrated the larva of a nematode in the brain and spinal cord of two affected cases, which is now believed to be the causal agent.

It is, however, important to note that it is the Japanese workers who first showed that the same disease in Korea and Japan was caused by youngworms—*Setaria digitata*. This was based on the association of worms with lesions and then later by reproduction of the disease experimentally in sheep, goats and horses. The etiological concept was first suggested by Fujita and later proved experimentally by Niimi, Kimura, and a total of 28 other Japanese workers. When INNES studied the histopathology of the brain and spinal cord of the Ceylon cases and compared with the descriptions and illustrations of the Japanese disease, he concluded that in fact the same process was involved in the Ceylon goats, and this led to the advice given to McGaughy who actually demonstrated the larvae in the affected goats in Ceylon.

Pathological Process produced by Causal Agent

The essential pathological process produced by the larva of the nemotade is that of a focal encephalomyelomalacia, which simply means softening of nervous tissue ; and this may

proceed to liquefaction and even cavitation in a few days. The lesions may be single, or there may be a few foci, but rarely are there disseminated changes. The process may attack any part of the nervous system, although it has been noted that the spinal cord, the thalamus or the cerebellum might be more commonly involved than other regions. Haemorrhage is not always present, for this would depend on the migrating worm striking main vessels, hence naked eye examination alone of the brain and spinal cord might not be sufficient to detect any pathological process.

Hosts and Vectors of Disease

The natural host of *Setaria digitata* is cattle, in which the filariae reside in peritoneum and mesentery without producing any visible pathological effect, and in which species microfilariae finally enter the blood. This same species of filaria is also said to affect other bovidae in South Asia. In Ceylon, mosquitoes and ticks may be the vectors in the normal course of events and transmit the microfilaria to fresh cattle hosts. The microfilariae, on being taken up by the insects, mature as infective larvae in about 14 days. When these are transmitted, however, to unnatural hosts, namely, sheep, goats and horses, they wander through the body and may finally migrate to the nervous system and produce therein the damage described above.

Treatment of Disease

As a result of McGaughy's findings (*vide* Brit. Vet. J., November, 1951), the writer undertook this year to find a chemotherapeutic agent which can be successfully used to treat cases of neural nemotodiasis. Since " Hetrazan " is known to be an effective drug in combating human filariasis and because Shoho in Japan used this drug successfully in his therapeutic and prophylactic trials in cerebro-spinal nematodiasis cases, we also chose the same drug in our therapeutic trials. This work was very urgent because the Department of Agriculture had to stop importing goats from India for development work in the Island because of this disorder among imported goats.

We treated nine cases of neural nematodiasis among Jamnapari and Saanan breeds of goats with 1—Diethylcarbamyl—4—Methylpiperazine citrate (" Caricide ". Veterinary equivalent of " Hetrazan "). The results definitely stand out to show that almost all the cases taken up responded to the treatment, the response being more dramatic in the very early cases. The animals resumed normal gait without any residual effects in about 10-15 days in most of the cases. In one case of long duration, the drug had no curative effect at all. The affected animals were given 40 mg/kg of " Cariside " repeated for three consecutive days in five cases and two consecutive days in four cases. It has been found that treatment should be undertaken at the very early onset of nervous signs if a cure has to be effected satisfactorily.

The success we have achieved through this pilot therapeutic trial has encouraged us to undertake wider and more comprehensive trials of this drug both as a prophylactic and therapeutic agent covering the entire Island, and a full report will be published in due course.

Work on experimental reproduction of the disease, studies of various insect vectors, and the various nematodes involved in this affection in Ceylon, are also under way.

Further reference in regard to this therapeutic trial with " Caricide " should be made to Ceylon Veterinary Journal, Vol. 1, No. 1, September, 1953, article by Perumalpillai and Perera.

Fertility, Hatchability, and Egg Production of Poultry at Ambepussa

P. MAHADEVAN

Introduction

A BREEDING project combining individual and family selection was initiated in September, 1951, at the Government Poultry Farm, Ambepussa, but this has since been abandoned for various reasons. Nevertheless, accurate egg production statistics for the breeding flock were maintained for a period of one year by daily trap-nesting, and data concerning the fertility and hatchability of 3,644 eggs were also collected. The birds were housed in breeding pens from September, 1951, to February, 1952, in the ratio of 8 to 10 females to 1 male. Of the females, approximately 75 per cent. were in their pullet year, while the remaining 25 per cent. had completed their first year's lay at the commencement of the breeding season. The males, however, were all cockerels. Eggs obtained by trap-nesting the birds from October to February were placed in specially constructed pedigree trays, incubated in a Mammoth Secura Incubator, and candled at eighteen days. The chicks were individually pedigreed at hatching. The entire data which relate to Australorps and Rhode Island Reds have now been statistically analysed, and the following is a brief résumé of the results obtained.

Results

IRRESPECTIVE of breed, the average fertility of all eggs set, as determined by candling on the eighteenth day of incubation, worked out at 84.2 per cent. An analysis of variance was carried out for each breed to determine whether the fertility percentages varied significantly for the months in which the eggs were laid, and for the different sires that were used in the breeding pens. However, it was necessary in this connection to transform the percentages to a suitable scale so as to make the variance independent of the mean. The transformation actually employed was the $\sin^{-1}\sqrt{p}$., i.e., the angle of which the sine is the square root of the percentage.

The results for the Australorps, which are summarized in the table below to illustrate the method of analysis, showed that although there is some variation in average fertility ranging from the highest value of 89 per cent. in October to the lowest value of 83 per cent. in December, this was not statistically significant. This suggested that the months October to February are about equally favourable from the point of view of fertility. The influence of the sires on the fertility of the eggs laid by the dams was also not significant in this experiment.

Analysis of Variance of Fertility (Australorps)

Source of Variation	*d.f.*	*Mean Square*	*F.*	*Significance*
Total	221	458·7		
Between months	4	139·3		
Between sires	5	80·6		
Sire-month interaction	20	397·9		
Between hens within sires	47	1008·2	3.24	* *
Remainder	145	310·8		

Among the Rhode Island Reds, however, the differences in fertility between sires were found to be highly significant. A detailed study of the R. I. R. data revealed that this was almost entirely attributable to the influence of one particular sire. Elimination of the data from the breeding pen which housed this sire and which produced only 64 per cent. fertiles, showed that the differences in fertility due to the remaining sires were not statistically significant. The differences between months were also not significant.

The overall differences between breeds as regards fertility were also studied, and it was found that the breed differences in fertility between Australorps and Rhode Island Reds were not significant.

In regard to hatchability, the average value for the two breeds was found to be 81.1 per cent. on fertiles and 68.3 per cent. on all eggs set. By analysis of variance of data transformed by the $\sin^{-1}\sqrt{p}$ transformation, it was found that there were no significant differences between months in the hatchability of fertile eggs in either breed. But the overall differences in hatchability between breeds, which averaged 83.4 per cent. for Australorps and 76.3 per cent. for Rhode Island Reds, were significant.

Total egg production figures for the year commencing September 1, 1951, and ending August 31, 1952, showed averages of 112.2 and 104.2 eggs respectively for survivors among the Australorps and Rhode Island Reds. The production of birds surviving the laying year is, however, not a very satisfactory criterion of egg yields in a flock, because it does not take into consideration mortality among the laying birds. The commercial objective of poultry farming is the production of a maximum number of eggs per original bird in the flock. A full economic accounting should therefore consider whether a bird died before producing enough eggs to pay for her replacement and other similar factors. But, practical considerations preclude the incorporation of all such factors in estimating the average production of a flock. Nevertheless, a satisfactory operational measure of the average production of a group could be arrived at on the basis of the original number of birds in the group, or on what is known as the hen-housed average or the production index. This is to be preferred to the hen-day or hen-month average not only because it takes into consideration the mortality picture in the computation of averages, but also because it preserves the randomness of the sample that is being investigated. For the flock studied, the production index was found to be 96.2 and 88.9 eggs for the Australorps and Rhode Island Reds respectively. While these figures are not very encouraging, they may nevertheless be accounted for as being largely due to the non-availability of uniform feeding stuffs throughout the year. Moreover, growth rates in early life are reputedly retarted in most tropical countries, resulting in delayed maturity and presumably in lowered production. In fact, the average age at first egg lay for the birds hatched out during the breeding season October, 1951-February, 1952, was found to be 209 days in the case of the Australorps and 255 days for the Rhode Island Reds. In recognition of this fact, plans are now afoot for a detailed study of the effects on growth and production of experimental chicken-starter, grower and layer-breeder rations compounded from home-grown feeding stuffs.

Commonwealth Agricultural Bureaux

H. T. P. SAMARASEKERA

Origin and Constitution

THE Imperial Agricultural Research Conference of 1927 recommended the establishment of eight bureaux to collect, collate and disseminate information on research in eight selected branches of agricultural science. The Conference also recommended that each bureau should be located at an Institute already well known for research in its particular branch, and that the cost of the bureaux be met from a common fund formed by contributions from Empire Governments. As a result of these recommendations, the Imperial Agricultural Bureaux came into being in April, 1929. In 1932, the Imperial Institute of Entomology and Imperial Mycological Institute were formed, while the Imperial Bureaux of Dairy Science, and Forestry, started work in 1938.

On the 1st January, 1948, the name of the organization was changed from " Imperial Agricultural Bureaux " to " Commonwealth Agricultural Bureaux ". Ceylon's financial contribution to the Bureaux is Rs. 30,000/-, voted annually in the Budget by Special Law.

The Executive Council controls the destinies of the Bureaux, and each member-Government has a representative on this body. H. E. the High Commissioner for Ceylon in the United Kingdom is Ceylon's representative on it.

Functions

These were laid down in 1928, following the Imperial Agricultural Research Conference, and have been amended and added to by successive Review Conferences. In brief, the Institutes and Bureaux act as clearing-houses for information of value to scientists and research workers in agriculture and forestry. They collect information by scanning and indexing, as far as possible, all journals in their subjects in all languages, and by keeping directly in touch with research in progress. They distribute this information by the periodical issue of fourteen abstract journals, by the publication of monographs reviewing some particular subject within their field, and by answering queries put direct by scientists and research workers, and in other ways. They also assist research workers by giving information about research centres, by arranging meetings, by arranging the exchange of experimental material, by giving information on post-graduate courses of study, on the sources of supply of apparatus, equipment, plants, stock, and so on. With the exception of certain work done at the Institutes, the organization neither undertakes nor initiates research. It is an intelligence service which keeps abreast of the results of research. Close touch is maintained with the Commonwealth countries and individual bureaux by a system of " official correspondents ", whereby each participating Government nominates a scientist who specializes in the subject of the bureau and keeps it informed of research developments in each country.

Publications

The following list shows the Institutes or Bureaux, their addresses, and the abstract journals regularly published, with the first year of publication:—

COMMONWEALTH INSTITUTE OF ENTOMOLOGY, 41, Queen's Gate, London, S. W. 7, England. *Review of Applied Entomology* (Series A—Agricultural) 1913. Monthly. *Review of Applied Entomology* (Series B—Medical & Veterinary) 1913. Monthly.

COMMONWEALTH MYCOLOGICAL INSTITUTE, Ferry Lane, Kew, Surrey, England. *Review of Applied Mycology*. 1922. Monthly.

COMMONWEALTH BUREAU OF AGRICULTURAL PARASITOLOGY, Winches Farm Drive, Hatfield Road, St. Albans, Hertfordshire, England. *Helminthological Abstracts* (Incorporating Bibliography of Helminthology) 1932. Five parts yearly.

COMMONWEALTH BUREAU OF ANIMAL BREEDING AND GENETICS, Institute of Animal Genetics, King's Buildings, West Mains Road, Edinburgh, Scotland. *Animal Breeding Abstracts.* 1933. Quarterly.

COMMONWEALTH BUREAU OF ANIMAL HEALTH, Veterinary Laboratory, New Haw, Weybridge, Surrey, England. *Veterinary Bulletin.* 1931. Monthly.

COMMONWEALTH BUREAU OF ANIMAL NUTRITION, Rowett Research Institute, Bucksburn, Aberdeen, Scotland. *Nutrition Abstracts and Reviews.* 1931. Quarterly.

COMMONWEALTH BUREAU OF DAIRY SCIENCE, National Institute for Research in Dairying, Shinfield, Reading, England. *Dairy Science Abstracts.* 1939. Monthly.

COMMONWEALTH FORESTRY BUREAU, Imperial Forestry Institute, South Parks Road, Oxford, England. *Forestry Abstracts*, 1939, Quarterly.

COMMONWEALTH BUREAU OF HORTICULTURE AND PLANTATION CROPS, East Malling Research Station, East Malling, Kent, England. *Horticultural Abstracts.* 1931. Quarterly.

COMMONWEALTH BUREAU OF PASTURES AND FIELD CROPS, Hurley, Nr. Maidenhead, Berkshire, England. *Herbage Abstracts.* 1933. Quarterly. *Field Crop Abstracts.* 1948. Quarterly.

COMMONWEALTH BUREAU OF PLANT BREEDING AND GENETICS, Cambridge, England. *Plant Breeding Abstracts.* 1930. Quarterly.

COMMONWEALTH BUREAU OF SOIL SCIENCE, Rothamsted Experimental Station, Harpenden, Hertfordshire, England. *Soils and Fertilizers.* 1938. Bi-monthly.

In addition to the abstracts journals, there are certain other regular periodicals for which the organization is responsible. These are:—

Bulletin of Entomological Research. 1910. Quarterly.
Zoological Record (Part Insecta). Yearly.
Distribution Maps of Insect Pests. 1951. 12 per year.
Commonwealth Institute of Entomology.
Supplements to the Review of Applied Mycology. 1940. Twice yearly.
Distribution Maps of Plant Diseases. 1942. 24 per year.
Annotated Bibliography of Medical Mycology. 1944. Yearly.
Bibliography of Systematic Mycology. 1947. Yearly.
Commonwealth Mycological Institute.
Index Veterinarius. 1933. Yearly.
Commonwealth Bureau of Animal Health.

Each member-Government receives a free quota of the above journals, the size of the quota being related to the number of units of contribution paid by each Government. Ceylon's quota is thirty journals, which are constituted as follows:—

Bulletin of Entomological Research	...	...	...	...	2 copies
Review of Applied Entomology, Series A	...	...	...	5	,,
Review of Applied Entomology, Series B	...	...	...	5	,,
Review of Applied Mycology	...	...	...	...	7 ,,

Soils and Fertilizers	1	copy
Veterinary Bulletin	1	,,
Nutrition Abstracts and Reviews	1	,,
Animal Breeding Abstracts	1	,,
Plant Breeding Abstracts	1	,,
Herbage Abstracts	1	,,
Horticultural Abstracts	1	,,
Helminthological Abstracts	1	,,
Dairy Science Abstracts	1	,,
Forestry Abstracts	1	,,
Forestry Abstracts	1	,,
Field Crop Abstracts	1	,,

These regular publications are supplemented by occasional publications which are reviews of published work on particular problems, especially those of current interest, or descriptions of experimental practice. These are variously known as Technical Communications, Joint Publications (where two or more Bureaux collaborate), Occasional Papers, Mycological Papers, Herbage Bulletins, &c., according to subject and series. Over 250 of these have been published by the organization. In addition, the Commonwealth Institute of Biological Control is producing a comprehensive catalogue of the Parasites and Predators of Insect Pests. Eleven volumes have so far been issued.

Information Service

Apart from the printed record, the Institutes and Bureaux serve as intelligence centres in a variety of other ways: some of these have been touched on earlier. Scientists are free to send inquiries straight to the Director concerned. These may range from requests for a few references to furnishing a bibliography or a memorandum of digested information. in the preparation of which several bureaux may co-operate where necessary. Reprints, photo-reproductions, micro-films, translations, &c., are also supplied.

BOOK REVIEW

Legumes in Agriculture—by R. O. Whyte, G. Nilsson-Leissner, and H. C. Trumble; F. A. O. Agricultural Series No. 21, 1953

ALL agronomists, particularly those in the tropics, desirous of having the more recent information on leguminous plants in various countries brought together in the compass of a small manual, should be grateful to F. A. O. for its latest issue entitled " Legumes in Agriculture " in the series of Agricultural Studies numbered 21. Since the publication in 1936 of " Use of Leguminous Plants in Tropical Countries as Green Manure, as Cover and as Shade " by the former Institute of Agriculture, Rome, the need for a more up-to-date review of forage and green manure legumes was keenly felt by many research workers and agriculturists interested in this important group of plants. No more appropriate body could have undertaken this task than the F. A. O., which can in a sense be considered the successor to the International Institute of Agriculture, Rome. The authors of this publication—R. O. Whyte, G. Nilsson-Leissner and H. C. Trumble of the Plant Protection Branch of F. A. O.—were assisted by 111 contributors from different countries, so that the information furnished must be taken as authoritative. The book has been well written and illustrated with several good photographs and tables. The type is clear, and there are barely any printer's errors.

There are two broad sections—Part I consists of 13 chapters, of which chapters 6 and 7 on " Use as animal feed " and " Tropics and sub-tropics " respectively are of special interest to agronomists in the tropics ; and Part II has a section on " Genera and species " followed by a Bibliography of a few publications to which reference is made in the text and lastly by a useful appendix on the characteristics of herbaceous and shrubby legumes. Chapter 7 in Part I is a precis of the replies to a questionnaire sent out by F. A. O. in August/September, 1951, and the section on " Genera and species " in Part II is based on the replies received to para 4 of the questionnaire. By some error, this questionnaire does not appear to have been received by the Department of Agriculture in Ceylon and, probably as a result, this country has been omitted from the descriptions of the legume position in different countries given in this chapter.

If the replies to the questionnaire had been carefully edited, the few errors which have been observed might have been avoided. For instance, botanical names do not appear to have been checked. The pigeon pea is referred to as *Cajanus indicus* in the accounts of legumes of certain countries and correctly as *Cajanus cajan* of others. *Indigofera subulata* now known as *I. retroflexa* is also mentioned by one or other of these two names. This is somewhat confusing to those who are unfamiliar with the periodical corrections that take place in the botanical nomenclature of plants. The suggestion is made that in the next edition an appendix may be given of the correct botanical names with those of the corresponding authors and the equivalent common names of all the species referred to in the text.

It is unfortunate that even in Part II the descriptions of species have been based on the information collated from correspondents without checking the correctness of these. If reference was made to the more recent literature on these legumes, some of these errors might perhaps not have occurred. In the case of Ceylon, there is the " Manual of Green manuring " published by the Department of Agriculture in 1931 and, more recently, the series of articles on legumes in *The Tropical Agriculturist* from 1949 onwards that might have been consulted. For instance, it is stated that *Desmodium triflorum* is often planted as a cover crop in rubber in Malaya, India, and Ceylon, and that it is not grown in tea because it climbs the bushes. Furthermore, it is considered to provide good fodder in hot climates and recovers well after grazing or cutting. In Ceylon at least, this species is of little value for the purposes mentioned, as it is a prostrate plant which seldom grows higher than 1 in. and has not been found to show any trailing habit. The seed is too small to collect without difficulty. Again, it is reported that the dried leaves, husks, and boiled seeds of sunnhemp (*Crotalaria juncea*) are fed to cattle in Ceylon ; but this is not so. It is only the young leafy tops that are occasionally fed. There is also a little

inconsistency in the information on species which are poisonous. Sunnhemp is recorded as being somewhat poisonous, yet it " may nevertheless be used as a forage in India, Ceylon, sub-tropical U. S. S. R., and part of Africa ". *Lathyrus sativus* is also listed as a poisonous species, but the foliage and seeds are held to be non-toxic and are used as forage, the seeds for human consumption as well. No reference, however, is made to the danger of lathyrism which develops if the seed which is known in India as Kesari dhal is eaten to excess either by stock or people.

Nevertheless the book contains much valuable information and it is likely to be in frequent demand for reference purposes. There are two sentences in the text which are commended to agriculturists in the tropics. They read as follows:—" But one very important attribute in tropical and sub-tropical countries is the provision of protection for the soil against the sun and rain. The primary object of agronomists and plantation managers must be to keep the ground covered and protected for a maximum period of the year ". What better way is there of achieving this than by growing legumes?

W. R. C. P.

RESEARCH NOTES

Paddy Pest Control

NEW machinery for spraying and dusting of paddy against pest attack has been tested under field conditions. A low volume power sprayer known as a mist blower, operated from the shoulders of a spray operator, has been tried out using DDT emulsion concentrates as the insecticidal formulation against paddy leaf hoppers and paddy swarming caterpillars, and almost complete control has been achieved. Two pints of a 15 per cent. to 25 per cent. DDT emulsion concentrate in 1½ gallons of water sprayed with the mist blower at the rate of 1 to 1½ gallons of the spray per acre has given the best control of these pests. Between 25 and 40 acres of paddy can be treated per day with one mist blower.

A power duster, weighing about 50 lb. when filled with insecticidal dust, and slung on the shoulder of the operator, has been tested for dusting with insecticides against paddy thrips and paddy bugs. Using a bezene hexachloride dust of about .5 per cent. gammaisomer content a maximum of 5 lb. of the dust was required per acre to give near complete control of these pests. One machine can be used to dust 50 to 75 acres of paddy per day effectively. Fixed wing (Auster) aircraft belonging to the Air Academy were tested recently for aerial spraying against paddy swarming caterpillars at Polonnaruwa and Minneriya. The spray rig installed in the aircraft was loaned by a private oil company in Colombo. Complete control of the pest was achieved in aerial spraying using 2 pints of an 18 per cent. DDT emulsion concentrate in 1½ gallons of water sprayed at the rate of 1½ to 2 gallons of spray per acre. Spraying was done at a height of 15 to 20 feet above the paddy. The cost of using fixed wing aircraft to spray paddy has worked out at Rs. 2.90 per acre excluding cost of insecticide.

Chilli Leaf Curl Control

INSECTICIDAL trials have been conducted to control leaf curl of chillies known to be caused by one or more of the following factors :—

(*a*) mechanical damage to leaves by thrips or mites,
(*b*) systemic infection by viruses.

Of the chemicals tested, sulphur wettable powders have given good control of mite leaf curl, while DDT and Toxaphene emulsion sprays have given almost complete control of mite and thrip leaf curl and an encouraging measure of virus control. With DDT (15 to 25 per cent.) and Toxaphene (40 to 50 per cent.) emulsion concentrates spraying was done using 1 fluid ounce of the emulsion concentrates in one gallon of water. Nurseries were sprayed once when the plants were two weeks old. Transplanted chilli plants

were sprayed 3 days to 1 week after transplanting and then at fortnightly intervals during the life of the plant. Harvesting of chillies should be done immediately before the next spraying. Pods should be dried in the sun for about 2 weeks prior to use.

Insect Transmission of Chilli Viruses

WHITE flies have been found breeding on chilli plants in the field at Peradeniya. This white fly has not been recorded in Ceylon on chilli and has been sent to the Commonwealth Institute of Entomology for identification. The life cycle of the white fly has been worked out and mass breeding techniques have been developed. Virus transmission studies with this white fly have proved that it transmits the vein clearing virus disease of chilli plants. Investigations using an aphis identified as *Aphis gossypii*, commonly found infesting chilli plants in the field, have proved that this aphis transmits the leaf mottle disease of chillies. Further investigations are proceeding to evaluate the finer virus—vector relationships of these two chilli diseases and also the alternate host plants of the viruses involved.

Cocoa Pests

A TRIAL is being conducted using DDT and Dieldrin formulations to control *Helopeltis* attacking cocoa plants. Dieldrin is being used as a low volume spray while DDT is being used both as a low volume spray and as a dust. Indications so far are that good *Helopeltis* control is being achieved with the sprays.

A leaf blast of young flush on cocoa observed in the field has been duplicated under experimental conditions using the cocoa thrips *Silenothrips rubrocinctus*. The effect of the feeding of the thrips is to produce dead areas on the leaf which soon disintegrate.

Insect Transmission of Cocoa Virus

THE relationship between the virus disease of cocoa and mealy bugs has been established by Dr. Walter Carter, FAO Entomologist. The vein clearing symptom on leaves of certain cocoa plants is clearly a symptom of virus disease and mealy bugs are the carriers of the virus. Two species of mealy bugs infesting cocoa plants, tentatively determined as *Pseudococcus lilacinus* and *Pseudococcus citri*, have given positive transmission of the virus disease. Data on a third species *Ferissia virgata* are incomplete. The vein clearing symptoms found on certain dadap trees used as cover on cocoa plantings are now thought to be those of the same virus disease found on cocoa plants. Experiments are under way to test this possibility. Further studies to screen most of the cocoa insects as possible victors of the cocoa virus disease and also to evaluate the intimate virus—vector relationships involved are being conducted.

Pineapple Wilt

EXPERIMENTS conducted by Dr. Walter Carter, F. A. O. Entomologist, have confirmed that pineapple wilt caused by the mealy bug *Pseudococcus brevipes* occurs in Ceylon. Field trials are being run in the Gampaha district enforcing wilt control practices from the stage when suckers are selected for planting.

Rodenticide Studies

FIELD and laboratory studies have been conducted with a new rodenticide known as Warfarin, a coumarin compound. In the control of rats in paddy fields (especially *Gonomys gracilis*) best results were obtained when a 1 per cent. Warfarin formulation was mixed with maize meal in the ratio of 1 part of the former to 19 parts of the latter. Approximately 3 oz. portions of the bait were placed in pieces of bamboo (1 ft. long by 5 to 6 inches diameter) which were located in several parts of the attacked fields (about 10 baits per acre). The baits were eaten freely and were replenished after daily inspection. After about 3 days baiting, rat damage to the paddy was negligible ; and, on about the 5th day after baiting commenced, rat damage was absent ; while an odour of putrefaction and dead or dying rats in the neighbourhood suggested the effectiveness of Warfarin. As Warfarin is a cumulative poison, baiting has to be conducted at least for 5 consecutive days before signs of mortality of rats are apparent. Laboratory studies with the house rat

Rattus rattus kandyanus have shown that this species of rat dies in 3 to 5 days of feeding on a 1 per cent. Warfarin-maize meal mixture with the former present in as low a ratio of 1/39 in the bait. These studies have demonstrated the following :—

(*a*) that no prebaiting is required when Warfarin is used,
(*b*) that rats are unable to distinguish between Warfarin-poisoned and non-poisoned food,
(*c*) no bait-shyness develops where Warfarin is used.

Comprehensive data obtained in the above studies will be reported in due course.

H. E. FERNANDO.

Two New Sap Transmissible Virus Diseases of Chilli

MOTTLE leaf of chilli is widely distributed throughout Ceylon. Slight differences of symptom expression in different locations suggested that more than one virus disease might be involved. Such was proven to be the case by sap transfer studies. Plants were found in the Jaffna Peninsula that carried a conspicuous light green foliage mottle with little leaf distortion. When the sap of these diseased plants was rubbed on to the leaves of healthy seedlings, the seedlings began to exhibit similar symptoms in eight days. The original plants were found where chilli was growing close to tobacco infected with the tobacco mosaic virus. This suggested that the two diseases might be caused by the same virus, and the experimental work supported this conclusion. Sap transfers from the diseased tobacco plants to chilli seedlings produced symptoms indistinguishable from those produced by the sap from diseased chilli plants, and the sap from diseased chilli plants produced typical tobacco mosaic symptoms when transferred to tobacco. It may be concluded, therefore, that the virus originally came from tobacco. It was probably transferred to chilli by mechanical means—on the hands of the workmen—for a large amount of investigational work by numerous investigators throughout the world have failed to reveal an insect vector of tobacco mosaic.

The mottle of the second disease of chilli is less conspicuous in that the dark and light green areas on the foliage are less sharply defined. There is, however, a greater tendency of leaf distortion to accompany the mottle, especially a constriction of the leaf tips. The disease appears to be much more widely distributed than the tobacco mosaic type. In some chilli plantings over fifty per cent. of the plants bore the mottle symptom of this disease before the plants had reached a foot in height. The disease differs sharply from the tobacco mosaic type in that it is not so readily transmitted by sap transfer methods to healthy seedlings. Sap transfers of this disease were successful only after the healthy chilli seedlings were kept in the dark for twenty-four hours prior to inoculation, and by using an abrasive. Also, the incubation period was longer—fifteen days compared with eight for the tobacco mosaic type. All attempts to transfer this second mottle disease of chilli to tobacco by sap transfer methods have failed. The random distribution of this virus disease of chilli in the field suggests that an insect vector is responsible for its spread.

W. NEWTON.

A Virus Disease of Cacao in Ceylon

THE symptoms of a suspected virus disease of cacao in Ceylon have already been described. The disease was characterized by the production on the leaves of vein clearing and " oak leaf " patterns. Technical proof of the actual virus nature was sought from two angles, viz., transmission of virus with mealy bugs from diseased to healthy cacao seedlings, and by bud-grafting diseased scions on healthy stocks. The results of these two lines of work are now available and conclusively prove the virus nature of the causal agent.

Using Posnette's method of cotyledon infection in seeds by infective mealy bugs, Dr. Walter Carter has obtained vein clearing symptoms in four out of sixty seedlings inoculated, and incidentally proved that two species of mealy bugs tentatively identified as *Pseudococcus lilacinus* and *P. citri* are the vectors of the disease.

Grafting experiments were carried out in the division of Plant Pathology and fifteen bud grafts were made on ten-month old healthy cacao seedlings, using buds from the axils of vein cleared leaves. Ten of the grafts gave successful bud union. Six of the successful grafts developed vein clearing symptoms, the earliest noticeable symptom appearing in seventy days. One of these grafts showed symptoms of " oak-leaf " pattern at the time of writing. Observations are being continued on the subsequent flushes of the infected plants.

J. W. L. PEIRIS.

Infectious Granular Vulvo Vaginitis among Cattle in Ceylon

IN Ceylon this disease was first brought to the notice of the veterinarian in 1952 when 3 Ayrshire cows examined for sterility at Undugoda Government Dairy showed minute pimple like lesions radiating from the clitoris. Thereafter the disease was diagnosed among the Tharparkar cows at the Animal Breeding Centre, Nikaweratiya. A subsequent survey showed that the disease is present in all breeds of cattle in Ceylon. As there were only sporadic cases, these were not brought to the notice of the veterinarian.

Reference to literature reveals that research workers are not agreed on the etiology of this disease and how it interferes with conception. According to some, the disease is unimportant. But our observations show that in the acute stage it interferes with normal conception.

The first noticeable clinical sign is a swelling of the labia of the vulva. There is a vaginal discharge which can be tenacious, odourless or mucopurulent. The lesions appear first round the clitoris. Later they extend radiating in linear fashion from the clitoris. The vaginal mucosa becomes sensitive and bleeds upon friction. In bulls, with this disease there are similar lesions on the penis and prepuce.

Silver proteinate given by gaseous dilatation method, silver picrate with kaolin as an insufflation, physiological saline and Lugol's solution as douches, have given varying results. We have had good results with a surface application of an emulsion made with acriflavine and " propamidine uterine solution ". Further work is being undertaken on the disease.

P. JEGANATHAN.

Veterinary Abstracts

KODITUWAKKU, G. E. (1953) " Pulmonary Embolism causing sudden death in cow, secondary to Thrombo-embolism and Chronic Phlebitis of the Posterior Vena Cava ". *C. V. J.*, Vol. 1, No. 1.

A sudden death of a five and a half year old Ayrshire cow was reported at a private farm about ten miles from Kandy. Postmortem examination revealed thrombosis, embolism, and chronic phlebitis of the posterior vena cava, and an embolus in the pulmonary artery.

Blood examined microscopically revealed no Anthrax bacilli.

The posterior vena cava as it passed through the medial aspect of the right lobe of the liver showed chronic inflammation. An embolus was found in the inflamed portion of the vessel. This embolus was obstructed by a laminated thrombus deposited on a valve. The vena cava posterior to the site of inflammation had anastomosed with a hepatic vein to bridge the obstruction caused by the diseased section of the vein. Thus the venous flow from the posterior quarters of the cow had been maintained. An embolus of similar colour and consistency as that in the posterior vena cava was found in the pulmonary artery There were no clinical manifestations of the pathological lesions in the vena cava.

MEETINGS

Central Board of Agriculture

Dr. A. W. R. JOACHIM, Director of Agriculture, presided and the following were present:— Mr. V. Cumaraswamy, M.P., Parliamentary Secretary to the Ministry of Agriculture and Food ; Mr. C. A. M. de Silva (Vice-Chairman) ; Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production ; Mr. S. C. Fernando, M.B.E., C.C.S., Deputy Commissioner and Registrar, Co-operative Societies ; Sir James P. Obeysekera ; Mr. T. Walloopillai ; Major E. C. de Fonseka, M.B.E., E.D. ; Mr. M. B. Samarakoon, D.R.O. ; Mr. W. M. Cumaraswamy ; Mr. N. R. Rajavarothiam, M.P. ; Mr. A. Perumynar, D.R.O. ; Mr. N. H. Kirthiratne, M.P. and Parliamentary Secretary to the Ministry of Posts and Telecommunications ; Mr. D. G. Dayaratne, C.C.S., Director, Rural Development ; Mr. U. B. Dedigama, M.B.E., R.M. ; Mr. U. B. Unamboowe, O.B.E., M.P. ; Mr. F. C. Cooke, Director, Coconut Research Institute ; Mr. R. H. Spencer Schrader, J.P., U.M. ; Mr. A. M. Clement Dias ; Mr. R. T. Chelliah ; Mr. Thomas Amarasuriya ; Mr. T. C. Rajaratnam, O.B.E., J.P., U.M. ; Mr. A. Hensman ; Mr. S. Sivapalan ; Gate Mudaliyar N. Wickremaratne ; Mr. Kenneth Morford, C.B.E., J.P., U.M. ; Gate Mudaliyar M. S. Kariapper, J.P., U.M. ; Sam Elapata Dissawa, M.B.E., J.P., U.M. ; Mr. J. A. de Silva, Conservator of Forests ; Mr. Albert Godamune ; Mr. Gladwin C. H Kotalawala ; Mr. T. B. Naranpanawa, D.R.O. ; Mr. W. T. I. Alagaratnam, Director of Irrigation ; Mr. L. S. Boys ; Mr. G. K. Newton ; Mr. A. T. Sydney Smith, J.P., U.M. ; Mr. S. L. Bandara Dharmakirthi, J.P. ; Mr. B. L. W. Fernando, Marketing Commissioner ; T. B. Poholiadde Dissawe, M.P. ; Mr. H. Abeyagoonasekera, D.R.O. ; Mr. F. A. Wickremasuriya ; Senator Miss Cissy Cooray, O.B.E. ; Senator Lady Molamure, O.B.E. ; and Mr. M. Sivanathan, C.C.S., Assistant Director of Agriculture (Administration), Secretary.

The following officials of the department were present on invitation:—Mr. C. N. E. J. de Mel, Deputy Director of Agriculture ; Mr. T. M. Z. Mahamooth, Deputy Director, Animal Husbandry ; Dr. W. R. C. Paul, Assistant Director (Technical) ; Mr. A. V. Anker, General Manager of Animal Husbandry Farms ; Dr. P. Mahadevan, Research Officer (Livestock) ; Dr. P. G. Malkani, Specialist in Animal Husbandry (Disease) ; Mr. W. D. E. Perera, Livestock Officer.

The following visitors were also present:—Dr. John W. A. Brant, F.A.O., Poultry Husbandry Expert ; Mr. E. A. Danbom, F.A.O., Animal Husbandry Expert ; Mr. A. H. Imhof, F.A.O., Expert in Extension Publicity.

Letters and telegrams regretting inability to attend the meeting were received from the following:—Sir Wilfred de Soysa ; Mr. S. Vythilingam, M.P. ; Senator C. Wijesinghe ; Mr. S. Pararajasingham, J.P. ; Gate Muhandiram A. D. S. Jayasinghe ; Mr. Anton C. Ponnampalam ; Mr. Marcus S. Rockwood ; Mr. K. W. Devanayagam ; Mudaliyar S. Armstrong ; Dr. H. E. Young, Director, Rubber Research Institute ; Mr. K. Kanagaratnam ; Senator Justin Kotalawala ; Dissawa H. B. Rambukwelle, M.P., J.P. ; Mr. V. Rajapakse ; Mr. S. A. Selvanayagam, M.B.E. ; Mr. J. Lamb, Director, Tea Research Institute ; Mr. P. B. Bandaranayake ; Mr. R. Singleton Salmon, C.B.E., M.P. ; Mr. S. M. Rasamanickam, M.P. ; Mr. H. Abeywickrema, M.P. ; Mudaliyar M. M. Ebrahim, M.P. ; Mr. M. Senanayake, M.P. ; Dissawa Sydney Ellawala, J.P. ; Mr. E. Muthukumaru ; Senator Barnes Ratwatte Dissawa, J.P., U.M. ; Mr. L. S. B. Perera, C.C.S., Land Commissioner ; Mr. A. D. Paranavitana, J.P. ; and Mr. S. Pathmanathan, Chairman, L.C.P.A.

I—Confirmation of the Minutes of the last Meeting

The minutes of the last meeting of the Central Board of Agriculture were unanimously confirmed.

At this stage Mr. R. H. Spencer Schrader inquired from the Chair whether it would not be possible to condense the minutes since all proceedings had been reported in detail and as such the minutes were very lengthy.

Gate Mudaliyar Wickremaratne observed that it was not correct to call them the minutes since they were actual proceedings of the meeting. He felt that a record of the actual proceedings was necessary so that the Minister and other officials in the Ministries may follow the discussions on various matters as they were put forward by members expressing different views.

The Chairman replied that that matter came up at the last meeting when the Minister himself was present and he was of opinion that the present practice of recording the proceedings should continue. He added that there was an advantage in recording proceedings in full because it helped the Ministry to know exactly the views of different members. He said that unless members felt very strongly that the minutes should be condensed he would suggest that the present practice of recording the proceedings in full should continue.

This matter was put to the House and a majority of those present were in favour of recording full proceedings of meetings.

Chairman: "I would like to say that I have had a message from the Hon. Minister, who expected to be present here today, that he has not been too well and that he has been forced to cancel his visit. Even this morning he phoned me up and was almost insistent on coming, but I replied that unless he was really fit I would not press him to do so. In the circumstances he decided that it was best for him to stay behind.

We have, however, our Parliamentary Secretary, Mr. Cumaraswamy, instead, and I welcome him on behalf of the Board. He is the person who will carry through our estimates in the Council and his presence here will be very helpful to us and at the same time of benefit to him for he will learn at first hand the views of members on the subject under discussion."

II—Discussion on Animal Husbandry

Chairman: "The next item on the agenda is a discussion on Animal Husbandry to be initiated by myself, the Deputy Director (Animal Husbandry) and the General Manager of Farms. If you will remember Gentlemen on the last occasion we met here we discussed in detail the subject of Food Production. And following on this discussion, the views, opinions, and suggestions, made by members will be conveyed to the Hon'ble Minister, now that the minutes have been approved.

The Committee which has been appointed to consider resolutions, known as the Resolutions Committee, met to consider a few resolutions which had been submitted for its consideration and it was determined that rather than have individual resolutions it was best to have different agricultural topics for discussion. Subjects such as Animal Husbandry, Crop Husbandry, Dry Farming, Food Production, &c., could be discussed in detail at these meetings. But any member who had anything to say or proposal to make in regard to the subject is perfectly free to bring it up in any form he likes. Formal resolutions are not really helpful because we are an advisory body and not an executive body. And it is left to the Ministry and the Government ultimately to determine to what extent our opinions or views can be accepted. The Resolutions Committee, therefore, determined that the policy which we should try and adopt in our deliberations should be to discuss the subjects under review in a general way, when members could express their opinions and views on them. I think it is a wise decision and, therefore, in accordance with that decision we have decided to review today the subject of Animal Husbandry in all its aspects. At the next meeting we hope to bring before you the subject of Dry Farming for discussion. Without further delay I would therefore proceed to the matter under discussion.

I propose to discuss the question of animal husbandry development in a broad and general way and will read from my editorial on the subject in *The Tropical Agriculturist*, copies of which have been circulated to you. It represents the joint views of the department on the subject. Detailed aspects of this subject will be reviewed by other members of the department. Dr. Mahamooth will review the work done in particular by the Veterinary Section of the department, and Mr. Anker, General Manager of Farms, that done on our Animal Husbandry Farms. We have also present Dr. Mahadevan, who is responsible for the breeding work of the department. He will be prepared to answer any questions which may be put to him in regard to the breeding of livestock in the Island." The following is a review by the Chairman:—

The Development of Animal Husbandry in the Island

The development of animal husbandry in the Island has from time to time been the subject of enquiry and investigation by various local Committees and visiting livestock experts. But, while as a result of the useful reports issued, there have followed praiseworthy but isolated efforts on the part of a few individuals or organizations to take advantage of the opportunities offered for new enterprise, it cannot be said that there have been any marked advances either in regard to the systematic development of the industry on an Island-wide scale or in regard to its economic status.

Despite the fact that the neat cattle population of the Island exceeds the million mark, the production and consumption of milk continue to remain extremely low as gauged by the imports of dried milk powder for use at milk-feeding centres, &c. This would indicate that by far the majority of our animals are unthrifty and of

little value as milch cows, and/or that they are so neglected and ill-nourished they do not even yield the small quantity of milk they are capable of. That the local Sinhala cow is generally uneconomic to maintain as a milch animal is confirmed by Dr. P. Mahadevan, Animal Geneticist to the department, in an article contributed to this issue of *The Tropical Agriculturist* on the results of his studies on the life and production statistics of the Sinhala cattle. The position in regard to the production of mutton and eggs for local consumption is not quite similar to that of milk, but the fact remains that the Island imported over 31 million eggs and from 5,000 to 6,000 goats each month during 1952. Only in respect of its beef requirements may the Island be said to be self-sufficient ; and that because of the ban on the import of cattle into the Island for slaughter as a safeguard against the re-introduction of rinderpest.

What then are the reasons for the parlous condition of the animal industry in the Island ? There are several, chief among them being the absence of a tradition of systematic animal breeding and management, and of mixed farming in the country ; the restricted use of milk in the diet of its inhabitants ; the religious susceptibilities of many of our people in regard to the use of livestock as food ; the inadequacy and poor quality of our pastures ; the limited credit facilities offered, rendering it difficult for those who have the knowledge to afford the means to embark on a new enterprise ; the absence, until recently, of organized marketing facilities for milk and other animal produce ; and the inadequacy of qualified personnel to organize the industry on an extensive scale. In order to remedy the backward state of the industry, the International Bank Commission in its report advocates the formulation and adoption of a long-term policy, particularly with regard to the breeding of cattle and the development of the milk supply. But any plans formulated for the development of an industry of the size and importance of dairy farming and animal husbandry generally would necessitate the fullest support and co-operation of all parties concerned with its successful execution. While Government, through the research, extension, and supply services of the Department of Agriculture, can foster and make a material contribution towards the development of animal husbandry in the Island, the fact remains that unless the people themselves, particularly those who have the means and knowledge to engage in the pursuit of livestock production, take full advantage of these facilities, little progress can be expected. Animal husbandry development in the country should be a co-operative effort between the Department of Agriculture and other Government bodies on the one hand, and organizations such as the Livestock Breeders' Association, the Colombo Co-operative Milk Union, the Ceylon Poultry Club, &c., and private parties on the other.

During the past few years the Department of Agriculture has intensified its efforts in various directions to promote the development of animal husbandry in the country, particularly in respect of dairying and poultry production. It realizes that unless suitably-trained personnel are available, satisfactory progress with any animal husbandry programme cannot be made. Accordingly, a number of our officers have been sent abroad for training in various branches of the subject and a nucleus of qualified men in animal husbandry has now been secured. As a first step towards our planned objectives, the Division of Animal Husbandry has been re-organized to incorporate three separate branches, viz., Research, Management (Farms), and Production or Extension, each with distinct functions and activities. Already the partial re-orientation of the research and farm policy has begun to bear fruit. Our livestock farms, of which there are now nine in the control of the Animal Husbandry Division, serve the main purpose of determining the breeds of cattle and other livestock best suited for the various climatic zones of the Island, and the most successful system of management under these conditions and of supplying selected breeding stock at reasonable prices to those engaged in animal husbandry activities. In addition, these farms have become important sources of supply of milk and other produce to hospitals, milk-feeding centres, &c. Last year as many as 425,000 gallons of milk were supplied to these sources from all our farms. It is hoped before long that most, if not all, of them would serve as models for private enterprise to follow. Despite the high overhead costs of Government undertakings and the sale of livestock produce at subsidized rates, a number of these farms are paying or will shortly pay their way.

Our extension service, in addition to making available veterinary aid for the control of animal diseases, is concerned largely with the establishment of stud centres in various parts of the country where stud bulls and goats of suitable breeds are stationed for the purpose of up-grading local stock. There are 240 such centres either entirely maintained or subsidized by the department. The number of stud bulls at these centres is 531, while of stud goats there are over 130. Artificial insemination centres have also been started and six are now in operation.

The department has also been alive to the importance of breeding draught and plough animals. With this object in view it has established three breeding farms for such cattle at Kilinochchi, Ridiyagama, and Karagoda-Uyangoda respectively. At the last-mentioned centre, pure-bred Sinhala animals are being reared with the object of improving the milk and draught qualities of the stock on the station. The importance of breeding suitable buffaloes for paddy cultivation has not also been overlooked, and for this purpose buffaloes are bred at five of our farms of which mention need only be made of Tabbowa, Ridiyagama, and Polonnaruwa. The Indian Murrah buffalo has been imported so that suitable crosses with local animals may be obtained. It is hoped thereby to breed an animal which will combine good draught and high milk-yielding characteristics. A project which is contemplated for execution as soon as the facilities for doing so arise is the breeding, on a ranch scale, of the excellent Tamankaduwa cattle which over the years appears to have developed into a valuable dual-purpose animal.

In this issue of *The Tropical Agriculturist*, Mr. H. Hirst, who was, until recently, Adviser in Animal Husbandry under the F. A. O. Technical Assistance Scheme, discusses the problems of animal husbandry in Ceylon, and furnishes suggestions for their solution. This article merits the serious study of everyone concerned with animal husbandry development in the country. The long-range plan to which reference has been made in it represents the agreed views of the department on the subject, and has been submitted to Government for its consideration. Reference is also invited to two other articles in this issue of this journal, viz., those by Mr. Anker Ladefoged, General Manager of Livestock Farms, and Dr. Mahadevan. The important points brought out by Mr. Anker in his contribution are that the nutritive value of tropical fodder grasses is low compared with that of temperate fodders and that dairy cows in the tropics do not consume enough of these grasses even to meet their maintenance requirements. Increased attention to the management and improvement of our grasslands is therefore urgently required. The subject of pasture grasses and legumes and fodders suitable for the different agronomic zones of the Island is being studied more intensively than in the past, and will receive the concentrated attention of an Agrostologist on his return from training abroad. Dr. Mahadevan's article has already been referred to and affords an interesting and authoritative study on the local Sinhala cow as a milk yielder. His view is that this low-producing animal, which has only registered an annual genetic gain in yield by selection of less than one per cent. of the average yield, is not going to be the solution to our milk production. Alternative breeding systems, such as crossing with foreign breeds of superior performance and inter-breeding the progeny with a view to evolving a new type, have to be tried out.

It is not possible in a brief note to refer to all that is being done by the department in regard to animal husbandry, but mention should be made of the efforts to improve poultry production through the Colombo Backyard Poultry Scheme and the Schools Poultry Campaign, in addition to the normal extension activities which have been undertaken throughout the country, e.g., the issue of pure-bred cockers and eggs at subsidized rates to bona fide villagers, &c.

In concluding this review it would not be out of place to enumerate the various measures which are suggested for the material improvement of animal husbandry in the Island. They are as follows:—

(1) The provision of marketing and credit facilities to prospective dairy and poultry farmers. In this connection the creation of a Milk Board at an early date would be of valuable assistance to such organizations as the Colombo Co-operative Milk Union, &c.

(2) The establishment of Co-operative Dairying and Marketing Societies among smallholders.

(3) The integration of animal husbandry with crop husbandry in the dry zone. With this end in view, animal husbandry research is to be undertaken at the dry farming research station, Maha Illuppallama, a main line of investigation to be the study of breed—environment interaction. There is ample scope for the development of animal husbandry as a second "crop" under coconuts in the low-country.

(4) The intensification of research on pastures and fodders, and the provision of stock feed at reasonable rates to breeders. The maintenance of adequate grazing grounds and pasture lands in all parts of the country is of considerable importance in this connection.

(5) The establishment of additional stud centres throughout the Island for the up-grading of stock coupled with the starting of two or three more artificial insemination centres where the need for them is most felt. Together with these measures the registration of approved or selected stud animals and the castration of scrub bulls is also of fundamental importance.

(6) The formation of Young Farmers' Clubs to promote movements such as the Schools Poultry Scheme, Co-operative Livestock Clubs, &c.

(7) The intensification of our campaigns against disease control, e.g., Ranikhet disease of poultry, hoof-and-mouth disease, &c. This aspect of animal husbandry will receive consideration in another issue of this journal.

Mr. T. M. Z. Mahamooth, Deputy Director (Animal Husbandry), addressed the Board next.

Mr. Mahamooth: "Mr. Chairman and Gentlemen, as already mentioned by the Director, I shall confine my remarks to the Veterinary Services." The following is a review by Mr. Mahamooth:—

Veterinary Services

The activities of the Veterinary branch could be considered under two heads:—(1) Laboratory services and (2) Field services.

Laboratory Services. The Veterinary Research Laboratory, under the supervision and control of the Specialist in Animal Husbandry (Disease), undertakes the examination of all pathological specimens received from the field for diagnostic purposes. They are subjected to cultural and biological tests whenever necessary in order to arrive at a correct diagnosis.

The laboratory also takes up investigation into veterinary problems with a view to reducing the incidence of animal diseases and thereby reducing mortality to the very minimum.

Investigations into the disease commonly known as "Goat Paralysis" have created considerable interest amongst research workers in other countries. The finding of the larval form of *Setaria digitata* in the brain tissues of affected goats has confirmed the findings of Japanese workers. Transmission experiments are in progress at present.

Since 1947 the Laboratory has made a valuable contribution in making itself self-sufficient in the matter of sera and vaccines required for the control of animal and poultry diseases in the Island. The above were imported from India and other countries at considerable expense to Government prior to 1947.

Mass vaccination campaigns against Ranikhet disease (Poultry Plague), Rabies, Anthrax, Black Quarter, &c., have been successfully carried out with the co-operation of field veterinary officers, and these have greatly reduced the incidence of these diseases in the Island.

Veterinary Hospital. The Veterinary Hospital, the only one of its kind under Government management, is run at Peradeniya. Outdoor and indoor patients of domesticated animals are treated. A nominal fee to cover the cost of drugs is charged. Large farm animals brought to the hospital are treated free of charge.

Field Services are manned by Assistant Veterinary Surgeons, 27 of whom are stationed in various parts of the Island, and assisted by Veterinary Conductors, Vaccinators and Veterinary Field Demonstrators trained in vaccination work.

The Assistant Veterinary Surgeon, though the smallest cog in the present set-up, is by far the most important officer, as it is on him that the department relies for the dissemination of information on improved methods of livestock management and prevention of diseases.

They give free advice on better methods of breeding, feeding, and management of livestock and poultry. They also advise owners on the treatment of minor ailments of livestock.

At present Assistant Veterinary Surgeons stationed at the following centres are in charge of small veterinary dispensaries. Sick animals brought to them are treated free of charge. Veterinary dispensaries are functioning at the following places:—Jaffna, Vavuniya, Mannar, Anuradhapura, Marawila, Puttalam, Matale, Batticaloa, Akkaraipattu, Kegalla, Pelmadulla, and Galle. It is proposed to increase the outdoor dispensaries to all places where Assistant Veterinary Surgeons are stationed, when suitable accommodation becomes available.

Veterinary Surgeons are always available for advice on diseases of animals and will carry out vaccination of poultry and dogs on direct application to them. In the case of outbreaks of contagious and infectious diseases they take all suitable preventive measures as expeditiously as possible.

The diseases that come under the Contagious Diseases (Animals) Ordinance enacted in 1909 and revised from time to time are—

In cattle

(1) Rinderpest
(2) Foot-and-mouth Disease
(3) Piroplasmosis
(4) Haemorrhagic Septicaemia
(5) Pleuro-pneumonia
(6) Anthrax
(7) Tuberculosis
(8) Surra or any form of trypanosomiasis
(9) Black Quarter
(10) Mange

In other animals

(1) Foot-and-mouth
(2) Anthrax
(3) Clanders
(4) Farcy
(5) Epizootic Lymphangitis
(6) Osteoporosis
(7) Surra or any other form of trypanosomiasis
(8) Piroplasmosis
(9) Swine Fever
(10) Swine Plague
(11) Infectious pneumonia of pigs
(12) Rinderpest
(13) Pleuro-pneumonia of goats
(14) Goat mange
(15) Pseudo Fowl Pest
(16) Tuberculosis

The Ordinance empowers the Revenue Officers of each province of the Island to proclaim infected areas and carry out control measures, and Government Veterinary Officers act in the capacity of advisers. In practice, whenever there is an outbreak of an infectious animal disease, the Government Veterinary Officer investigates on the spot, advises the Revenue Officer of the area to be proclaimed, and takes all quarantine and sanitary measures.

In the case of bacterial diseases a tentative diagnosis is given until the Veterinary Officer's findings are confirmed by the Veterinary Research Laboratory after cultural and biological tests.

Ceylon is free from Rinderpest since 1946. The eradication of this disease after a campaign lasting about three years was one of the greatest achievements of the Veterinary Section. Ceylon is the only country in South-East Asia to be free from this disease, besides the Phillippines ; and it is incumbent on us to take every precaution to prevent its re-introduction.

Mr. Anker Ladefoged, General Manager of Livestock Farms, delivered the following address:—

Activities on the Major Livestock Farms

It is hardly possible to formulate a long-term breeding policy in a country unless some established facts about the reaction of different breeds and grades of livestock to the prevailing conditions are available ; and it is therefore very essential for the successful development of an Animal Husbandry industry that facilities for investigating into the improvement of breeding, feeding, and management of livestock, are provided.

The fact that Ceylon has got very variable environmental conditions makes it necessary to have a number of stations devoted for breeding and investigations established in different parts of the country. The combined facilities available in Ceylon are very considerable, comprising some 4,000 head of stock and about 15,000 acres of land.

There are at present 9 farms which can be classified as breeding and experimental farms, viz.:—

IN THE UP-COUNTRY AREA— Bopatalawa and Ambawela are intended to breed European cattle and pigs.

IN THE LOW-COUNTRY DRY ZONE—

Polonnaruwa ... ... For breeding of Indian breeds of cattle, Murrah buffaloes, and Jamnapari goats.

Nikaweratiya ... ...Breeding Tharparker cattle and poultry.

Ridiyagama ... ...Breeding Kangayam and Red Sinhala cattle and cross-breeding experiments with local buffaloes and Murrah buffaloes.

Kilinochchi ... ...Breeding Khillari draught cattle and goats.

WET LOW-COUNTRY—

Karagoda-Uyangoda	... Conducting pure-breeding as well as cross-breeding with the local Sinhala cattle.
Undugoda	... On this farm a nucleus of Jersey cattle was established recently in addition to the commercial herd already there.
Ambepussa	... Besides maintaining a commercial herd of cattle, it is the main station for poultry breeding.

Out of these 9 farms, 6 are now under the general management of the Livestock Division in the department.

The purposes of the farms are, as already mentioned, to gather data in regard to breeding, feeding, and management, with the ultimate object that herds maintained should serve as the foundation stock on which to build planned improvement of livestock throughout the country. When judging the contribution of the farms so far towards that end, one should realize the fact that the majority of the farms are still comparatively newly established and that breeding of cattle is a very slow business. Important results cannot be expected to be available as long as the farms are still in an undeveloped stage. The problems involved in the development of the farms were many, and it was therefore often the case that more attention had to be paid to the development side rather than to the real objects of the farm.

During the last few years, however, the objects of each farm have been reviewed and each farm now has a clearly defined purpose and programme of work covering not only a long-term policy but also a short-term one, and the aim being to make the farms as useful as possible to the country.

Although the objects may differ a little from one farm to the other, they can generally be described as follows in respect of all farms maintaining dairy cattle:—

(*a*) Breeding and issue of animals to the public.
(*b*) Milk production and demonstration to the public that farms of this nature can be economically run.
(*c*) To carry out investigations into feeding and farm management, with particular attention to fodder production and pasture establishment under prevailing conditions.

The breeding policy followed on the farms was, until recently, to maintain pure-bred animals, judge the relative merit of individual cows and bulls, and to study the suitability of the different breeds under prevailing conditions. A more consistent breeding policy formulated by the department's Livestock Research Officer is now being followed, and scientific principles and methods of breeding now form the basis on which all breeding farms are run. Definite breeding programmes incorporating recent scientific advances in the field of genetics, e.g., progeny-testing and breed-environment interaction, have been laid down and are being followed with scrupulous care.

The advantage of having a large herd of cattle on each farm makes it possible to carry out experiments on a broad basis and to carry out progeny-testing under uniform conditions. This means that proved bulls can be made available to the public in appreciable numbers for improving the local cattle population. The introduction of artificial insemination will make it possible to use such proven sires on a large scale. Drastic culling of all low-producing animals is being done continuously, the aim being to improve the herds and not merely to multiply.

Environmental and management problems such as heat tolerance, reproductive efficiency, and handling of animals, are all objects for investigations in order to make sure that animals are allowed full expression of genetic characters. The importance of environmental factors must not be overlooked as about 70 per cent. of the variability of milk production is due to these, while only 30 per cent. is due to genetic factors.

The yearly issue of animals from the major breeding farms amounts to about 1,000 head of cattle and buffaloes, besides several hundreds of goats and pigs.

Although milk production on farms devoted for breeding of dairy cattle is considered a secondary object, it is most essential that everything possible is done to obtain maximum yields, primarily because high yields is the very purpose for which we breed ; and secondly because high yields mean high income per cow, and therefore for the farm. Good cows should naturally also be economic cows, and farms maintaining such animals should therefore, if well stocked, also be economic concerns.

During the last 2-3 years a drive to increase milk production was undertaken, and on three large milk-producing farms—Bopatalawa, Ambawela, and Polonnaruwa—resulted in an increase of some ½ million pints or 40 per cent. This, along with other measures such as culling of low-producing animals, reduction of labour, better marketing of produce, and more economic feeding, has brought about a better economy on these farms.

From an yearly loss of about Rs. 700,000 they have now for the first time got a balanced budget and are therefore no more an economic burden to the country.

Along with breeding and production, investigations are carried out to find the best methods of feeding and management. The introduction of better pastures and increased production of home-grown fodder have made it possible to bring about a more economic use of purchased concentrates.

Mention has already been made in regard to the different breeds kept in different farms, and I shall only refer to a few more points in this connection.

There are in Ceylon a multiplicity of imported breeds both European and Indian, and our efforts are now aimed towards eliminating those breeds of cattle which are unlikely to be of any importance for improvement of local stock. It is therefore intended to test the value of these breeds under identical conditions, so that in time to come the number may be reduced to 2 or 3 European breeds and preferably one Indian breed. As regards European breeds, a decision has already been made to eliminate the Red Polls (these are now being graded up to Fresians) ; while for the Indian breeds, this line of work is now in progress at Polonnaruwa. The Jersey herd is so far the European breed which has found favour in tropical countries, and the suitability of this breed to Ceylon wet low land conditions is therefore now being tried out at Undugoda Farm.

At Karagoda-Uyangoda pure-breeding as well as cross-breeding experiments are being conducted with the local Sinhala cattle ; and, realizing that in the Island this breed forms the bulk of the cattle population, this work is considered as being of major importance. As regards buffaloes, the activities are still of recent origin, but it is intended to devote Ridiyagama farm for this particular object—with a breeding programme comprising both pure-breeding of Murrah buffaloes and cross-breeding with local buffaloes.

The major livestock farms have only a few years ago been brought under one control, the management conducted by a special division within the Department of Agriculture. The advantage of such centralized control is obvious, as the investigational and experimental work now carried out can be conducted on well planned lines, and it ensures more continuity in management.

The major livestock farms have many and difficult problems to solve, and the progress of animal husbandry in this country will to a great extent depend on how the farms will be solving these.

Chairman: " Gentlemen, we have heard the official side of the story. Before we come on to the unofficial side, I have to mention that we have had letters regretting their inability to attend the meeting from 22 members. I do not think it is necessary for me to read the names, as the list will be published in due course. There have also been requests from two members, Messrs. Wijesinghe and Vytilingam, for leave of absence from meetings of the Central Board. The period of leave asked for is four months from one member and six months from the other. I take it that you have no objection to the granting of this leave. " This was granted.

" We will now proceed to the discussion on the problems of animal husbandry in the Island. "

At this stage Major E. C. de Fonseka said that in December last he had sent in a resolution to be placed before the Animal Husbandry Committee. The resolution read as follows:—" The Central Board of Agriculture, as a matter of great importance, recommends to the Hon'ble the Minister for Agriculture and Food that a separate department of animal husbandry and veterinary services be established under his Ministry at an early date in the best interests of the country, as the present administrative set-up of placing Veterinary Officers under the Divisional Agricultural Officers has not resulted in any appreciable improvement in Animal Husbandry and disease control work, which is evident from the results of the past 16 years of amalgamation of the two departments."

Major Fonseka continued: " Well gentlemen, I consider this resolution one of paramount importance and I fully expected that this resolution would be included in today's Agenda. I understand that the Resolutions Committee had decided that this resolution could be discussed along with a general discussion on animal husbandry, similar to the discussion on Food Production. While thanking the Resolutions Committee for

their advice, I fail to understand why this resolution has not been included for today's discussion. I do not want a discussion on this resolution, but I want it proposed and seconded and put to the House for a definite ruling because of its far reaching results. It is not a resolution that can be discussed at a round table conference like this.

"May I even, Sir, find out from you whether it is proposed to bring this up as a resolution at a subsequent meeting?"

Chairman: "The Resolutions Committee state that it is within your power to bring this matter up for discussion and you can bring it up now in the course of our discussion on animal husbandry."

Major Fonseka: "Can I bring it up now in the form of a resolution, Sir?"

Chairman: "I would like to state that we are not an executive body but we are an advisory body. Even if you move a resolution and the Board passes it, it is by no means obligatory on the part of the Ministry to implement it because it is for Government alone to determine matters of policy. But there is no objection to you or any member bringing this question up as representing his view on the subject. Other members could support it in the course of their talks, if they so choose to."

Major Fonseka: "What is the serious objection to this matter coming up later in the form of a formal resolution?"

Chairman: "In the past a number of resolutions were passed by this body which could not be given effect to. We therefore felt that, being an advisory body, we should merely express our views on the subject relating to any particular discussion and leave it to the authorities to decide on the issues. Copies of these proceedings are sent in full to the Minister so that he will be in a position to judge."

Major Fonseka: "I can appreciate the fact that ours is an advisory body, but I fully expected this resolution to come up today. When I sent this resolution, what I had at the back of my mind was that the amalgamation of these two departments had not produced the results that should have been produced. To give you a history of this amalgamation—in 1935 the Headquarters of the Veterinary Department was in Colombo. Then the Minister of Agriculture thought that it would be a good idea to transfer the Headquarters of the Veterinary Department from Colombo to Peradeniya so that there may be greater co-operation between the two departments. Next year, in 1936, the two departments were amalgamated under one head. The Director of Agriculture was made head of the two departments, and he had two Deputy Directors. one being Deputy Director (Animal Husbandry). When this amalgamation took place the Veterinary Surgeons came directly under the Divisional Agricultural Officers. These Divisional Agricultural Officers formulated the policy ; and, in my opinion, the present parlous state of the animal husbandry industry of this country is mainly due to this very unfortunate set-up. Instead of the Veterinary Surgeons coming directly under the Deputy Director of Animal Husbandry, they came under the Divisional Agricultural Officers. I know some of them are very good and very hardworking, but they are very busy people and they do not have the time nor a knowledge of the animal husbandry policy. I do not want to make a lengthy speech, but I can confidently say that if these two departments were separate and worked independently greater results would be achieved. This country has so much scope for veterinary work, I would suggest that the Director of Agriculture remain as the head of both departments, with the Veterinary Surgeons coming under the Deputy Director of Animal Husbandry. There should be Divisional Veterinary Officers corresponding to the Divisional Agricultural Officers. I am not in the habit of throwing bouquets to those who do not deserve them. In the Deputy Director of Animal Husbandry we have a very capable man ; but what can he do when his hands are tied? There is much dissatisfaction among the Veterinary Officers and they are a disgruntled lot of people. All these bring a sense of frustration into the minds of the Veterinary Officers. If this matter is gone into and if the department is allowed to work on the lines I suggest, within a very short time this question of producing more milk, more eggs, and so on, would be solved, and that is why I sent this resolution, Sir, for discussion."

Chairman: "This is one proposal, viz., that for more effective results in animal husbandry we should separate the Veterinary Section from the Department of Agriculture. Other gentlemen are also free to make proposals."

Mr. R. H. Spencer Schrader: "Mr. Chairman and Gentlemen—I have already sent in a memorandum which you had been good enough to circulate. I have not got very much to add to that, but I do want to say a few things, particularly with regard to our local cattle. I do not in any way wish to undertake the work that is being done by scientists, but it is noteworthy that all the British breeds of cattle were

established by practical farmers. To name a few, Bakewell was responsible for the Longhorn; the Colling brothers brought the Shorthorn into existence; Mc Combie produced the Aberdeen—Angus; the Marets improved the Jersey, using only the native Jersey cattle. " Mr. Schrader read the following from some notes he had. Hugh Watson, a Forfar Farmer from whose stock Mc Combie evolved the Aberdeen—Angus, did some very intensive in-breeding, and in five generations he produced the originator of the breed, Old Jock, who had only six ancestors instead of sixty-four to begin with. The purity of the Jerseys is most jealously guarded and no animal may be imported into the Island; any animal once taken out may never be brought in again. All these were practical men without any training in genetics, but with common sense and acute observation. They knew what they wanted and they set to work to get it.

The trained scientist had nothing to do with the evolution of the breeds; they came in later and were able to explain in scientific language how the results were obtained, the part played by the genes, and how hereditary factors were transmitted. All the results have been beautifully and very accurately explained, but it was the practical men who got them.

The tendency now a days is to treat the breeding of stock just as if it were a mathematical problem. Mathematically the result C may be a combination of the two factors A and B. If we were dealing with inorganic substances this result may be invariable ; but in dealing with living things, a combination of A and B may produce anything from C to Z, because in life there is much about which we are in complete ignorance. There are such things as mutations or " sports "; there may be inhibitions about which only a little is known, and that only that they occur. It is not known why they occur, nor when they will occur.

In the case of poultry, it is well known that a silver hen cannot pass the silver factor to her daughters. A silver cock will pass the factor to both sons and daughters. If a silver hen were mated to a gold cock, then the daughters will, without exception, be gold: on the other hand, a silver cock mated to either a silver or a gold hen will have offspring, both sons and daughters, with the silver factor. If silver is the characteristic that is desired, then it can only be produced by correct mating—in other words, the parents must " NICK ". If they do not nick, the desired characteristic will not be transmitted. Bateson and Punnet, after years of patient research, have explained very accurately how the silver and gold factors behave in poultry, but " nicking " was a phenomenon well known to practical farmers long before them.

So far as our local cattle are concerned, we are in absolute and complete ignorance of their composition, constitution, and capacity for improvement. We do not know whether their small size is a hereditary characteristic or due to bad management and poor feeding. We have never made any serious attempt to find out whether they have in their composition any factor which, with proper encouragement, will produce a tendency towards heavy milk yields. It has been assumed, without anything to justify the assumption, that our local stock is completely lacking in the hereditary capacity for improvement. We have condemned them as having no value without making any effort to find out what value they may have. So far as attempting to improve them is concerned, we have allowed ourselves to suffer from a sort of mental constipation, and the only thing prescribed for this condition is cross-breeding ! "

At this stage he added: " We are told that Dr. Mahadevan has done some work with regard to this at Karagoda-Uyangoda, where the herd had been kept for a matter of 10 to 15 years. In 10 to 15 years one cannot say whether the relative progress in the future can be one per cent. Then, the total milk shown as produced at the three Farms did not necessarily indicate improvement. The per capita yield was not given. Working it out, hurriedly, I made the average about 2,000 pints per head for the first two years. In the third year there was an improvement, but that was explained by Mr. Anker who had stated that the low production cows had been culled. The improvement therefore was not due to breeding. "

Mr. Schrader continued from his notes— " To turn now to the question of pastures. Here again, the sovereign cure that had been prescribed for the shortage of grazing up to a few years ago, was to grow imported fodders. I think I may claim to have been one of the first to bring to the notice of this Board that we had many indigenous grasses which, with proper cultivation, would make good pasture, and that Brachiaria distachya was one of them. Dr. Paul will, I am sure, confirm that the first plot of this grass to be laid down at the Walpita Farm was from cuttings supplied by me. But the local grasses will never become popular unless they are given popular names. To the man in the street, Brachiaria muticum means nothing ; call it " Water Grass ", " Diyathanakola ", or " Tanni-pillu ", and he immediately knows what we are talking about. It was only after Stillingfleet gave the English grasses popular names that improvement in the pastures of Britain began to take place.

Because the local grasses have no popular names, the plots on the Government Farms bear labels with only the Latin names, and these are forgotten immediately the visitor turns his back on the plots. Until we have popular names, we shall always speak of Napier, Guinea or Water Grass ; all the others will be, collectively, " Wild Grass ", " Wal-thanakola " or " Kartu-pillu ". I should like to suggest, therefore, that a small Sub-Committee (three members will be enough), be appointed to go into this matter and name the local grasses. Give labels with the Latin, English, Sinhalese, and Tamil names, and the grass plots on the farms will prove vastly interesting and improvement in the pastures will follow."

Mr. Spencer Schrader added: " In regard to Major Fonseka's suggestion I would like to say that animal husbandry is quite distinct from Veterinary Science. If Major Fonseka will agree with me, I shall support him gladly that the Veterinary Services be run separately, but the Veterinary Services should not be mixed up with extraneous matters like animal husbandry, which is fundamentally a matter for the Agricultural Service. If that is possible I think it would be an excellent thing."

Following is a copy of the memorandum submitted by Mr. Spencer Schrader, copies of which were circulated among members:—

MEMORANDUM ON ANIMAL HUSBANDRY

In this memorandum, which I submit to the Central Board of Agriculture for consideration at the forthcoming meeting, I propose to confine myself entirely to the question of cattle.

The small size of Sinhala cattle is a characteristic that has struck everyone who has seen the breed. Owing to this smallness, the breed is nearly always held in contempt, and whenever any suggestion is made that the size should be improved, the only method considered is crossing with some imported breed. Crossing with a bigger breed may result in offspring bigger than the Sinhala cattle in the first generation, but the question is what the next step should be. If one crossed back to the Sinhala, one goes back to smallness; if one continued with the bigger breed, genetically one would eventually produce this breed ; if one introduced a third breed into the scheme of things, the tendency would be to produce mongrels. If it is decided to continue with the bigger breed, then there is a factor that has to be considered. Bigger animals require more food than small ones. Unless this extra food is given, the tendency to bigness will disappear ; and the animals, while resembling the imported breed in many characteristics, will become as small as the Sinhala cattle.

It is clear that size is correlated with the food supply, and if the Sinhala cattle are fed adequately improvement in size will follow naturally. The semi-wild cattle in the Tamankaduwa district, where there is a certain amount of natural selection, affords an example. What is now taking place in the Ruhuna National Park would be well worth watching. Some time ago a number of local cattle entered the Park. They have multiplied in numbers, and a small herd has got into the Strict Natural Reserve. But the numbers are controlled both by leopards and the severe periodical droughts that affect this area, and the numbers are not greater than the food supply will maintain adequately. Selection is entirely natural, and only the fit survive. Already there are indications that a new type of animal is being evolved. During a recent visit to the Park I saw two magnificent bulls, one black and the other red; all the animals were in grand condition, but both for condition and size these two bulls were outstanding. Nowhere have I seen Sinhala cattle that could compare with them, and both humps and dewlaps left nothing to be desired.

If, in a few years, improvement such as can be seen in the cattle in the Ruhuna Park has taken place under purely natural conditions, it should not be impossible, under human management, to effect similar improvement. But it must be appreciated that either under natural conditions or under the best human management, improvement can only be effected by a process of evolution, which although slow is constructive. To attempt to attain the end we seek by taking short cuts, such as crossing with a bigger breed without adequate feeding, is revolutionary and destructive.

One of the evils suffered by our cattle, chiefly on coconut estates, is the yoking together of two miserable animals in order to prevent them straying. I repeat once more what I have said time and time again: if two head are yoked together, either both have to subsist on half rations or wander about a double distance to find a full one. In dry weather or where the land is over-stocked with miserable animals kept for the purpose of manuring the palms, the latter becomes impossible. The pernicious system of yoking animals together to prevent them straying may save the owner the wages of a cattle-keeper, but results inevitably in degeneration. Would it be too much to ask the Hon'ble the Minister of Agriculture to consider the enactment of legislation to make this wicked system an offence?

Another evil, almost as common as the previous one, is to send a herd out to the roads to pick up whatever they can find to eat in the ditches. Day after day, these miserable animals wander miles to find an utterly inadequate supply of food. Neither on coconut estates nor in the case of the " roadside feeders " are any cattle given a small additional ration of concentrates to eke out the totally inadequate supply of fodder available for their normal maintenance. These conditions of almost criminal bad management are common, and where they exist, cattle, whatever their breed, must degenerate.

The Government Farms are excellent in their way, but undue importance appears to be attached to the imported animal. The vast majority of cattle owners are small men who can neither afford to buy any of the breeds kept nor feed the bigger animals. The only impression that can be created in the mind of the visitor is that Government can keep these beautiful cattle purely because they have the resources, which the small man has not. A visit to one of the farms is really no more helpful to the small man than a visit to the zoo. If, instead of the visitor feeling that he cannot afford to follow the example set by Government, he begins to realize that there are many things that he can do himself without much expense, things that will give him profitable results, then the farms will become really helpful and will serve a very much more useful purpose than they do now. It is useless spending a lakh of rupees on doing something and then telling the man who cannot afford to spend a hundred: " Go thou and do likewise ".

The value of stud centres where big bulls of imported breeds are kept with a view to improving the local cattle in the neighbourhood is doubtful. The cows that are served are usually small and under-nourished. It is extremely probable that calving would be difficult. Registers may be kept at these centres that would show the number of cows served. Is there any means of ascertaining the number of: (*a*) healthy calves born ? (*b*) still births? (*c*) cows that die during parturition? (*d*) calves that show any improvement over their dams in development? After all, the value of the stud service does not lie in the number of cows served but in the improvement in the progeny. If the progeny show no improvement, and if the number of services is the chief consideration, then any scrub bull would be just as useful as a bull of an imported breed.

There can be no question that milk production hinges entirely on improvement of the cattle. The vast majority of the cattle are local, and of owners, the small men, who cannot afford animals of any other breed. It becomes abundantly clear, therefore, that the first requirement in any scheme for increasing milk production is necessarily the improvement of the local cattle. It is equally clear that improvement would be impossible if the animals remain under-nourished. An under-nourished cow cannot produce and feed a big healthy calf ; an under-nourished calf cannot develop into a big healthy cow. So long as the cows are fed inadequately, any attempt to improve the stock by mating them to a good bull would be futile.

Yoking cattle together to prevent straying, over-stocking land, neglect of the pastures, and failure to supply the smallest ration of concentrates, inevitably cause under-nourishment in the stock and loss of soil fertility in the land. If any sound scheme of animal husbandry is to be evolved, it cannot be too strongly emphasized that only one step may be taken at a time. In the words of Cato, the Roman philosopher, uttered more than two thousand years ago, the first of all the steps should be " To feed stock well ". Everything else will follow.

Dr. P. Mahadevan in reply to the observations of Mr. Spencer Schrader said: " The first point Mr. Schrader raised was improvement of cattle with regard to milk yield. We got to bear in mind that cattle are a gift of nature in some countries like New Zealand and Great Britain. But unfortunately, nature has not been so bounteous as regards cattle in this country. It therefore becomes an uphill task to produce a breed of cattle that would not only adapt itself to our climatic conditions but would also produce a sufficient quantity of milk. In other words, in a country like Ceylon, it is necessary to contest nature in producing a breed of milch cattle to suit our requirements.

Mr. Schrader referred to my paper on the rate of genetic improvement in milk yield actually attained by selection in a herd of Sinhala cattle at Karagoda-Uyangoda, and wondered whether the relative progress in the future can continue to be one per cent. In this connection, I would draw Mr. Schrader's attention to the fact that at least six investigations have been made within the last three years—and at least three of them from Ceylon—to determine not only the rate of genetic improvement actually attained in different herds but also the maximum rate of improvement possible under optimum conditions of selection. All these investigations point to the fact that the maximum rate of genetic improvement possible in a herd of constant size is one per cent. of the average yield per year. It is possible to illustrate the reasons for this low rate of improvement by reference to a herd containing 100 head of cattle. Let us assume that the owner of this

herd wishes to do the most stringent selection of dams of cows and dams of bulls to bring about genetic improvement. Anyone familiar with the management of a herd will realize that not more than 25 of the 100 cows in any herd can be culled every year. The reason for this is that on the average only twenty-five heifer replacements will be available to the herd owner each year. Now, if we accept the fact that only 25 cows can be culled per year, the superiority of the remaining 75 cows over the original 100 cows can be shown by simple statistics to be 8 per cent. of the herd average. Of this 8 per cent. only one quarter is genetic, as the heritability of milk yield is around 0.25 per cent. That means an effective genetic superiority of 2 per cent. Of this 2 per cent. only one half is transmitted from dam to daughter. The next generation would therefore be superior to the parental generation by only one per cent. of the initial herd average. Since the interval between generations for the Sinhala cattle is approximately six years, this would indicate a rate of genetic improvement due to selection of dams of cows of under 0.2 per cent. per year. In like manner, it should be possible to calculate the rate of genetic improvement obtainable by selection of dams of bulls. Allowing for more stringent selection on this side, the total genetic improvement per year under optimum conditions cannot still exceed one per cent.

So much as regards genetic improvement. We are also aware that it is possible to improve yields by measures other than genetic, and in fact experiments have been in progress for the last 1½ years or so to determine the effect of plane of nutrition on production in the Sinhala cattle. One of the experiments that was designed to throw light on the effect of calf nutrition on ultimate productivity suggests, at the present stage, that although early maturity of the Sinhala cattle may be obtained by good nutrition during calfhood, there does not appear to be any significant increase in ultimate size of the animals. However, the final results of these experiments should, I believe, be available to members of the Central Board of Agriculture at their next meeting or the meeting after that.

Mr. Schrader has also referred to individual yields of cows on our farms as being in the region of 2,000 pints per cow. For his edification, I will quote the average yields that we have actually obtained for 1952-53:

	gallons
Friesians	534
Jerseys	364
Red Polls	345
Shorthorns	376
Ayrshires	443
Scindis	228
Sinhala	115

There are a few points that I would like to raise regarding the memorandum submitted for this meeting by Mr. Schrader. The impression that this memorandum has created in me is that Mr. Schrader is very concerned about improvement in size of the Sinhala cattle. There is no mention of any other sort of improvement. As far as the Department of Agriculture is concerned, we do not consider the correlation of .2 to .3 per cent. that has been obtained between certain body measurements and milk yield sufficiently large to worry about when breeding for milk production.

A few other statements made by Mr. Schrader need, I think, not be taken seriously. He says in one place that ' If one introduced a third breed into the scheme of things (cross breeding) the tendency would be to produce mongrels '. Surely, at least some of you gentlemen are aware that at least two of the new recognized breeds of cattle in different parts of the world are the result of admixtures of different proportions of blood from three distinct breeds.

There is one statement, however, of Mr. Schrader's to which I wish to take serious objection. Mr. Schrader says ' But it must be appreciated that, either under natural conditions, or under the best human management improvement can only be effected by a process of evolution, which although slow is constructive '.

My objections to this are as follows. The science of biometrical genetics has now come to a stage when it is possible not only to assess but also to predict within a reasonable degree of accuracy the rate of genetic improvement possible under a given breeding system. It has thus been possible to show that under the conditions obtaining in this country, that even under the most stringent artificial selection, it would take over 200 years to raise the average level of production of the Sinhala cattle in Ceylon to anything comparable to the yields given by Jersey cattle under local conditions. How much more ineffective would natural selection be when the aim of natural selection is certainly not increased milk yields ?"

Replying to a question by Mrfl Schrader, Dr. Mahadevan said—"It is no doubt an accepted fact that most of the dairy breeds of today have been produced largely by the efforts of practical farmers. But as I mentioned earlier, these breeds have been developed in countries where nature has been bounteous in providing the environments suitable for them. We in Ceylon and those of our colleagues in other tropical and sub-tropical countries are not so favourably endowed by naturue's gifts, so that we are in the unenviable position of having to contest nature in order to produce a breed of cattle suitable to our requirements. It is here that we need to use science and scientific technology to satisfy our needs."

Mr. Clement Dias: "Mr. Chairman, Ladies and Gentlemen—I am rather frightened to speak in front of two experts, Dr. Mahadevan and Mr. Anker. I am glad to learn from the Administration Report of the department for 1951 that there has been a great improvement compared to previous years. I am sorry that some figures are not given, so it is rather difficult to find out which is which. I am not a scientist but I am a practical planter and a farmer, and I have done certain cross-breeding and I like to mention results. I am glad to hear that the department has an idea of keeping about two or three European breeds and one Indian breed. Today we have twelve pure breeds of cattle maintained on Government Farms. I suggest that you keep Jerseys, Friesians, and Ayrshires, for the up-country and mid-country districts. For the low-country districts I suggest that you keep the Scindi, Tarparka, and one breed of Sinhala cattle." Mr. Dias suggested that Red Polls, Shorthorn, and Sahiwals, be disposed of and that a choice be made from the best Sinhala Black and Sinhala Red for breeding purposes. He felt that cross-breeding of cattle should be encouraged only to evolve a new milk breed suitable for low-country districts. He added—"Of course Dr. Mahadevan does not agree with this suggestion." He also suggested the Khilari breed of cattle for the Jaffna district.

In regard to the stud bulls which were imported into this country, he deplored the practice of getting the animals through Crown Agents. He said that it was not possible to select cattle in that manner. Stud bulls of European breeds should be bought through the Cattle Breeders' Associations of England. He added that a proved stud bull of the Jersey, Friesian, or Ayrshire breed, would cost about Rs. 20,000 to Rs. 30,000. He suggested that young stock should be brought from England once in two or three years to introduce new blood into the herd maintained in Government Farms. He said that a young animal would cost about Rs. 6,000. He did not approve of the practice of buying cattle through the Crown Agents or cattle dealers.

The other point he mentioned was that whenever breeders asked for cattle from State Farms, they were sold either culled animals or cross-bred animals as pure-breds. He emphasized that that was a serious mistake of the farms and hoped that that would be remedied in the future. He added that it was very necessary that people should have sufficient faith in the Government and Government Farms. He said that in farms he had visited in Denmark and Holland, the history of each animal was recorded for generations; whereas, in Ceylon, farms did not maintain such accurate records.

In regard to the breeding of cattle he said that it was an uphill task which was bound to cost money. He suggested that leaflets and books on cattle breeding be made available in English, Sinhalese, and Tamil. He remarked that every coconut estate could be a cattle farm if coconut estate owners were given the necessary facilities to breed cattle, and opportunities were provided for the transport and sale of milk. He said that Government would never succeed in its attempt to produce more milk in the country unless Milk Marketing Boards were established. He said that in his own estate he maintained a herd of cattle and that he was finding it difficult to dispose of the milk even at 20 or 30 cents a bottle. He said that if there was a Milk Marketing Board, all hat milk could have been disposed of in Colombo. He also stressed the fact that more of the dairies in the Island were not run on proper lines because the chief purpose of the owners was to make more and more profit. During his visit to some of the farms in Denmark he was surprised to hear that any animal which gave less than 18 bottles of milk was sent to the butcher. He also mentioned that the worker in England was really proud of his job unlike in Ceylon. He had asked one of the gentlemen present at the dairy, how many milkers there were, and the reply had been very prompt that there were three milkers and he was one of them.

Mr. Dias also mentioned that cattle-breeding and pig-keeping were done together in most countries. In Denmark there were piggeries in many of the cattle farms. He said that pigs were able to put in a weight of about 200 lb. in a short period of 7 or 10 months. He felt that rearing of pigs should be encouraged in Ceylon and that pork should be sold at a fair price.

In regard to goat-breeding, Mr. Dias suggested that British Sannon goats should be imported from England. He said they were able to produce about 12 bottles (?) of milk a day. He felt that it would be possible to rear them in a cold climate and cross them with local goats.

Regarding poultry, Mr. Dias suggested the crossing of R.I.R. cockerels with Light Sussex hens and Black Leghorn cockerels to R.I.R. hens. He said that cross-breds were able to thrive well and lay in a short time.

In conclusion Mr. Dias said that if there were Research Institutes for the necessary advice on Tea, Rubber, and Coconut, it would be a great advantage if there was an Advisory Board to tender advice to the public on methods of breeding cattle, &c. He felt that two Advisory Boards, one for cattle and one for poultry, would be very advantageous. Mr. Dias also suggested that improvement of cattle-breeding should be started district by district or from one korale to the other. Finally he remarked " If you want to improve cattle-breeding, there should be a Milk Marketing Board ".

Mr. A. Perumynar, speaking next, said that just as there were some accepted improved methods of cultivation for increasing the production, it would be feasible to establish some accepted and approved methods of breeding and better looking after of animals.

The first thing he would suggest was that out of a number of bulls in the country side, a certain number would not be regarded as bulls of a category that should be allowed to do breeding. In that respect he felt that the Department of Agriculture should intensify the castration of unwanted scrub bulls. He did not think that adequate efforts were being made at present in that direction. He said that intensive castration should be done in as many villages as possible.

The second point he would like to stress was in regard to pastures. He said that adequate pastures were not available in the villages and inquired whether any authority or any department had taken the responsibility upon himself or itself to provide adequate and better pastures for the cattle in villages. He felt that in many areas adequate pasture land could be reserved for the use of the villagers so that cattle of a particular village could graze in that area. He said at present most of the cattle owned by villagers were either let loose on the road or were fed in the neighbour's garden, so that in practice although he does not steal he gets his cattle to steal.

The next point he would like to touch upon was about the difficulty of disposing of the milk produced in this country. He said that there were more and more Milk-feeding Centres established at present and that every effort should be made to encourage pure milk in those centres instead of the powdered milk imported from abroad. He added that although pure milk was more preferable to powdered milk from abroad, Milk-feeding Centres and the people who patronized them had a greater preference for the imported milk food. He said that there must be some reason for it but it was most peculiar. But he added that if the economic condition of the parents of the children was to be improved, Government should compel Milk-feeding Centres to buy fresh milk.

In regard to stud services to villages, Mr. Perumynar said that as it was not possible to have stud bulls supplied to all farmers or to all villagers, the only method possible was to have stud animals for groups of villages. He also suggested the establishment of more board and lodging schemes for the benefit of villagers. At present, he said, the villagers had to take their cattle sometimes 5 or 10 miles to a stud centre with a great deal of difficulty, and with all that sometimes the service was found to be ineffective. He added that just as there were pureline paddy breeding stations, there should be centres from which villagers and cattle breeders approved by the department should be able to purchase good animals at subsidized rates so that a better type of animal may be introduced into the villages. At those centres, he said, that even eggs and pure-bred poultry could be supplied.

Gate Mudaliyar M. S. Kariapper thanked the officers of the department for the very valuable papers they had read at the meeting. He said that no further papers would be necessary to convince them of the supreme importance of livestock breeding. He added " Having been convinced, we fail to put it into effect ". He said that the problem of livestock breeding should be studied district by district, because difficulties in one district were different to those of the other. He felt that sufficient attention in that direction was not paid to Kalmunai District because there were not enough pasture lands. When there were no pasture lands it was no use finding out what breed of cattle would thrive in such a place. He said that the most important problem was to provide sufficient pasture lands in the various Provinces

of the Island. He believed that that was one of the chief reasons why the cattle of this Island were degenerating. He hoped that Dr. Mahadevan would be able to tell them how many head of cattle could be maintained on an acre or 5 acres of pasture land.

Gate Mudaliyar Kariapper also inquired from the Director of Agriculture what new species of cattle he had in mind when he used the expression " Sinhala cattle " both in his editorial of *The Tropical Agriculturist* for the 4th Quarter, 1952, and in his speech that afternoon.

The Chairman replied that the term Sinhala cattle was used to differentiate local from the imported cattle. In which case, queried the Gate Mudaliyar, how could he bring within this expression the cattle in the Northern and Eastern Provinces? Why not use the non-communal expression Ceylonese Cattle ? (Laughter.)

In conclusion Gate Mudaliyar Kariapper appealed to the Board to see that, above everything else, sufficient pasture lands are provided for the cattle of this Island, as otherwise all other action will be meaningless and a waste of time.

Mr. T. B. Naranpanawe, D. R. O., commenting on the unsatisfactory state of affairs regarding ownership of cattle, said that branding of cattle was not compulsory as it was some years back, but now it was optional. In the N. C. P., neat cattle generally grazed in the jungles and buffaloes were for a greater part of the year in the jungles except during the cultivation season. He said that owners paid very little attention to their cattle in the N. C. P. Sometimes entire cultivations were damaged by cattle and Government officials and cultivators were trying to find out ways and means of preventing that damage. The difficulty experienced was that whenever damages were claimed from the owner, there was no owner. He said that cattle-lifting was another problem, and cases often failed in Courts as it was difficult to establish the ownership of cattle in the absence of compulsory branding. On the other hand, he said, often two villagers claimed the same calf, one having imposed his brand marks over those imposed by the other on the animal—villagers doing their own branding—and the dispute was settled by one villager swearing, as agreed upon, at a local temple that the animal was his. Mr. Naranpanawe added that in their Rural Development meetings that matter was discussed, that individual farmers had expressed their opinion, and that it was agreed that there was no solution except compulsory branding. Mr. Naranpanawe in conclusion said that that was a matter which deserved the consideration of the Board and that in his opinion compulsory branding of cattle was the only solution.

Gate Mudaliyar N. Wickremaratne said that he would first wish to express his thanks to the Deputy Director of Animal Husbandry for the eradication of Rinderpest from the Island, and added that he was glad that since 1946 the Island had been free from Rinderpest.

He said that the subject of cattle in Ceylon was very welcome and that he would take the opportunity to express his views which were embodied in a memorandum, and that he would urge the authorities to take necessary steps to develop the breeding of cattle in Ceylon. He explained that, in the days gone by, the people of Ceylon considered a herd of cattle owned by a family as a " Wealth " and so did they consider children in a family. Therefore in his own words he expressed the view that " Cattle Wealth is only next to Child Wealth ", and said that it was a Sinhalese saying. He added that, besides the usefulness of cattle for cultivation purposes to a village family, to own a herd of cattle was considered to add to the status of the family. He said that it was a traditional saying among the Sinhalese (in the South) that a cow and a Kitul tree provided the dowry of a village maiden.

Gate Mudaliyar Wickremaratne also explained how it was possible in those days to take a cow on the " ande " system for rearing, from the village landlord. Some landlords allowed half share while others allowed one-third share to the " Andakaraya ", as the person who took charge of the cattle on the " ande " system was known. He also said that it had been the practice among villagers to leave out a " yaya " of paddy land which was used as a grazing ground for all the cattle in the village. The " yaya " in question was changed every season so that the old " yaya " could be used again for paddy cultivation. He added that the lands thus used were so fertile with " natural manures " that the paddy crops were very large. He also explained the practice that had prevailed in the villages when cattle were not tethered as at present but were allowed to move freely in the harvested tracts. If any crops such as vegetables were grown, those fields were fenced in order to prevent damage from cattle.

Mudaliyar Wickremaratne was of opinion that the opening up of roads in villages, the practice of cultivating paddy in every tract that was available, and with the opening up of land for other plantations, the grazing grounds in the villages disappeared ; and, as such, rearing cattle became a burden on the villager. Gradually the villager began to give up his cattle and ultimately even the plough gave way to the " mammoty " owing to the shortage of buffaloes. He said that it was very rarely that a plough was used in the Galle District, as turning the earth with a " mammoty " was the most common practice. Consequently the supply of milk and milk products such as ghee, curd, whey, butter, &c., reduced to a minimum. The result was that the villager had been robbed of the five forms of food, or " Pasgorasa " as was termed in Sinhalese, which was available to him without much expense, and now the result was a nation of ill-nourished men and women. He emphasized that the first and the foremost step the Government should take was to open up more pasture lands in the villages and provide the villager ample opportunities of rearing cattle. Mudaliyar Wickremaratne also quoted a statement made by the late George Wall as regards the availability of cattle in very large numbers in this country. He referred to an English writer who had seen countless numbers of cattle, 2 to 3 thousand head in one herd, in park-like country side, without owner or master.

In his own travels from Kurunegala to Hettipola many years ago, Gate Mudaliyar Wickremaratne had come across several hundred head of cattle lying on the road so that he had to drive them with the help of others and use the road. He cited this instance to show that the cattle population of the Island was very much greater some years back than at present. He added that before the opening of the Tamankaduwa District for colonization of Minneriya and Polonnaruwa there were large herds of well-nourished and good-looking cattle, but at the present time such a sight was rare and it was difficult to see cattle of that standard. Mudaliyar Wickremaratne therefore urged the Government to take sufficient safeguards to preserve the few cattle that remained in that district.

Gate Mudaliyar Wickremaratne mentioned how cattle thefts were reduced to a minimum by the efforts of the late Mr. Ellis who was appointed to report on the matter. His recommendations were the registration of cattle and the introduction of a voucher system and also the prohibition of removal of cattle from one village to the other without a permit. Those recommendations were implemented and proved most successful, but later owners of plantations had complained of the permit system and it was abolished. At the beginning of the last War the question of the development of animal husbandry came up for discussion at the Central Board which recommended the abolition of branding of cattle and registration. He emphasized that it was the implementation of that recommendation which led to the decline of the cattle population, because all the available cattle in the villages found their way to the slaughter-house. Even buffaloes which were essential for cultivation purposes found their way to the slaughter-house.

Mudaliyar Wickremaratne also mentioned the efforts of the then Government Veterinary Surgeon, Dr. Sturgess, and his Assistant, Dr. Hoole, in a scheme of selecting good stud bulls from among the local cattle and castrating the animals that were considered unfit. About that time a few Kangayam bulls from Madras were imported into the Island and given over to village centres with the hope of introducing new blood into the local herd. Even that scheme did not prove a complete success till after the late Mr. D. S. Senanayake who, in his office as Minister of Agriculture, gave the fullest encouragement for the improvement of agriculture and animal husbandry.

In regard to the policy of the Government in importing foreign breeds of cattle into the Island at considerable expense, he emphasized that that was a scheme " which helped some well-to-do people to purchase their cattle at periodical sales ". He inquired how many of those superior breeds had penetrated into the villages? He emphasized that village cattle could be made to meet the ordinary requirements of a village family with a little more care and attention to the animal, but it was too much to expect a villager to look after foreign breeds which required so much attention.

Gate Mudaliyar Wickremaratne suggested that an area of 5,000 acres be set apart in Polonnaruwa on the right bank of the Mahaweliganga in the North-Central Province where pastures and grazing grounds are already available. He said that similar areas could be selected in the Wanni Hat Pattu, Giruwa Pattu, Mannar, and Vavuniya. He suggested that separate paddocks be maintained for milk cows, young heifers and bullocks, &c., and that a separate place should be reserved for other cattle. He also felt that Veterinary Surgeons should be employed at each of those places to look after the health of the cattle and select stud

bulls for breeding and castrate the unfit animals. He added that a Co-operative Society would prove of value in such a place for sale of milk, curd, and ghee, and even cattle for transport purposes and those to be sent to the butcher.

Mudaliyar Wickremaratne also suggested that a number of suitable villages be selected with a view to introduce good breeds of cattle from Government Farms, on the " ande " system. The Government should take an interest in their supervision and advice so that after a few years the cattle given on the " ande system " could be transferred to other villages.

In conclusion Mudaliyar Wickremaratne suggested that the villagers in the North-Central Province and other areas should be assisted by Government to look after their cattle in a more systematic way so that milking, feeding, and tethering them, would be done on the proper lines.

Mr. N. H. Kirthiratne, M.P. and Parliamentary Secretary to the Ministry of Posts and Telecommunications, said that it was surprising that this country was importing 31 million eggs and five or six thousand goats every year. He said that the policy of the Government should be to gradually reduce its imports of eggs, goats, &c., by increasing the production within the country. He added that fortunately no cattle were imported owing to certain restrictions imposed by Government on grounds of preventing the spread of disease. He also advocated the holding of propaganda meetings and fixing targets for the production of more milk. He said that there were about 20 Kachcheri Divisions and that each officer could be in charge of an area, who should be responsible for the improvement of cattle in his area. By that means it was possible to have a five-year or a six-year programme so that at the end of it the country would have achieved some success. He felt that District Agricultural Committees could help a great deal in that direction. As an encouragement to the rearing of goats in villages, especially in the Anuradhapura area, he suggested that, if possible, Government should give a subsidy as was done in the Jaffna District for the encouragement of onion cultivation.

In regard to Major Fonseka's suggestion to separate the Veterinary Department from the Agricultural Department, Mr. Kirthiratne suggested that since Government Agents and Assistant Government Agents were responsible for so many other departments under them, the Veterinary Surgeon in each area could be placed directly under the G. A. for administrative purposes although the Veterinary Surgeon would work independently, so that the defects in the Veterinary Department which had resulted in the Veterinary Surgeons being placed under Divisional Agricultural Officers might be wiped out.

Mr. Kirthiratne also mentioned about the immediate necessity for more pasture lands and believed that jungle lands in the N. C. P. and other areas could be utilized for pasture lands. Commenting on the pasture position of the country, Mr. Kirthiratne wondered if there was a possibility of producing packets of pasture in a concentrated form for about 10 or 15 cents so that they would contain the same nourishment as a heap of grass!

Mr. Kirthiratne also felt that people in villages did not look after their cattle sufficiently well as long as they were able to do the ploughing. He said that instead of importing foreign breeds of cattle, an effort should be made to improve the local breed. He said that the encouragement to produce more milk should come from Government, so that if the current market price was 50 cents a bottle and Government offered 75 cents a bottle at various purchasing centres, people would somehow see to it that more milk was produced. He also emphasized the necessity for encouraging pure milk in all Milk-feeding Centres.

Mr. W. M. Cumaraswamy said that as a practical farmer and a breeder of cattle he was able to say that although foreign breeds of cattle were good producers of milk it was beyond the means of the ordinary villager to look after such an animal. He had the experience of maintaining an Ayrshire which produced 23½ bottles of milk, but it was not economical to the ordinary villager. He said he was President of a Co-operative Dairy in Jaffna which owned about 60 dairies, each dairy having about 8 to 10 cows, and that he was therefore in a position to know something about milk-production and cattle-breeding. He said that as long as a cow was producing sufficient milk, the calf was well looked after ; but the moment it went dry, the calf was either neglected or sold for about Rs. 10. He added that the fundamental problem behind was the economic factor. He said that there was no point in scientific animal-breeding unless the problem of feeding was solved.

Referring to the problem of pasture, Mr. Cumaraswamy inquired how even a 100 acres of pasture land could help the situation when for nine months out of the twelve months there was no rain. Invariably the

cattle were only under the shade of trees while the ground was bare. After that long spell of drought, at the appearance of the first few showers the grass sprouts up, and the cattle who fed on them began to purge, losing the little strength they had.

Mr. Cumaraswamy also commented on the uneconomic price the producers obtained owing to transport difficulties. He felt that Government could help bona fide cattle breeders by offering them an economic price and also by providing them transport facilities.

As a solution to the pasture problem he said that the Parliamentary Secretary would agree with him that there were tracts of fields even in the North which were unsuitable for paddy cultivation, which could more advantageously be turned into pasture land. He suggested that Government should make a start with some of those unsuitable paddy lands and provide fodder and pasture to bona fide cattle breeders at reasonable prices. He added that at present a bundle of grass weighing about a pound was sold for 3 cents, whereas if there was a scheme to supply grass at 1½ cents people would jump at the idea.

Mr. Cumaraswamy also stated that milk produced in certain Government institutions such as Farm Schools were sold at uneconomic prices without any consideration of the cost of production because they were financed by Government, so that private dairies were forced to compete with Government prices although the price was not economical. Therefore the only way out of the difficulty to private dairymen was to adulterate their milk. As a result of that practice Government dairies were able to maintain the quality but their supply was limited.

Mr. Gladwin H. Kotalawala referring to Major Fonseka's resolution said that in his Province. the G. A. was not in a position to check the work of the Veterinary Surgeon because he was not a technical officer. Under those circumstances he wondered whether Major Fonseka would bring it up as a resolution. He also thanked the Director for giving them an idea of the true position of State Farms, and added that perhaps the Director's memorandum was issued as most of the statements made in the Press in regard to farms were not quite correct. He inquired whether it was possible to table a statement of profit and losses incurred by the three major farms of the department—Bopatalawa, Ambawela and Polonnaruwa.

In conclusion Mr. Kotalawala appealed to the Parliamentary Secretary to induce the Minister to implement the motion under discussion because, it being the 3rd meeting of the Central Board, there was no point in discussing unless some motion was implemented.

Mr. W. M. Cumaraswamy referring to the Veterinary Services of the Island explained some of the difficulties the people had to undergo as the Veterinary Surgeon was stationed miles away from where the sick animal was. He added that even after a Veterinary Surgeon was consulted, people were forced to go miles out in search of drugs or to get the prescription dispensed. As a solution to that problem he suggested the introduction of two or three mobile hospitals with an Assistant Veterinary Surgeon in charge.

The Chairman said that in regard to the point raised by Mr. Gladwin Kotalawala, profit and loss accounts of the three major farms were available, and Mr. Anker read them out to the Board.

Mr. Kenneth Morford, while agreeing with the views expressed by Mr. Anker in his address, inquired whether the small-scale breeder could adapt himself to conditions described as ideal. He also drew attention to the fact that Veterinary Surgeons should especially be entrusted with the job of preventing diseased and unfit bulls from breeding.

In regard to rules imposed on breeders of cattle, requiring milk rooms, &c., of a certain standard, Mr. Morford said that those rules were really good but the difficulty was whether the ordinary breeder could afford to fulfil the requirements of the law. He felt that too rigid an imposition of such rules would even discourage the small breeder.

Mr. Albert Godamunne enumerated the various difficulties the country was facing in regard to the shortage of buffaloes for cultivation work. He said that formerly the hire of a buffalo was only Rs. 2 per day but at the present time it was Rs. 20 per day. The result was that paddy fields were not ploughed properly and some were even left unploughed. He therefore suggested that, as was proposed sometime back, buffalo farms be established in each D. R. O's Division so that such farms might meet with the immediate requirements. He also suggested the opening up of more pasture lands in villages.

At this stage Dr. Mahadevan replied: "There has been a question of scarcity of buffaloes in this country. From the latest *Tropical Agriculturist* I gather there are some 570,000 buffaloes. Of these we may estimate 200,000 to be adult. Taking the reputed 1 million acres cultivation as an accurate figure, we still have about 1 buffalo to 4 acres".

Chairman: "We have had a very full discussion on the subject, and before I ask the Parliamentary Secretary to address us I would like Dr. Mahamooth to address the Board on certain points that were raised".

Mr. Mahamooth said that, in regard to the question of castration of bulls, Veterinary Surgeons stationed in various districts were entrusted with that work, but it was felt that the castration of useless bulls in the country had not made enough impression. He hoped that with the appointment of more trained officers the situation would improve. Sometime back the department had even suggested that legislation be introduced in regard to castration, but so far it had not taken shape.

In regard to the question raised by Mr. Perumynar, he would like to mention that there already existed a few board and lodging stations for the benefit of the villagers. He added that, as suggested by Mr. Perumynar, board and lodging schemes were very useful and helped the villagers to develop their herds. Referring to the artificial insemination that was done by the Veterinary Department, he said that artificial insemination was not practicable in certain areas but the introduction of this facility in board and lodging schemes was considered feasible.

As regards the branding of cattle, Dr. Mahamooth said that branding was compulsory till about the year 1937. After a couple of years, it being not compulsory, cattle were not branded at all. As a result of cattle-branding being made optional, cattle thefts increased considerably, especially in the War years, and most of the villages became a fertile ground for certain unscrupulous people who resorted to thefts. Owing to constant cattle thefts, owners have felt the need for the reintroduction of branding and registration of cattle. Even though haphazard branding could spoil the hide, the owner was not worried as long as his cattle were safe from thefts. Therefore the owners preferred to brand their cattle and have them rather than not brand them and ultimately lose them. Referring to certain notions that prevailed among a certain section of the public that branding of cattle is a cruel act which is injurious to the animal, Mr. Mahamooth said that branding could be done without injury to the animal and that the department had the necessary appliances for it. That was possible by heating the iron to the correct degree and branding the animal below the thigh. He added that there was a method of branding by the use of certain chemicals but that was not a permanent brand and lasted only for a year or two so that re-branding was essential.

Mr. V. Cumaraswamy, M.P. and Parliamentary Secretary to the Minister of Agriculture and Food: "Mr. Chairman and members of the Central Board of Agriculture. In fact I expected to be here with my Minister. Unfortunately, for various reasons, Sir Oliver Goonetilleke was not able to be present here and I like to say a few words to you since I have been called on by the Chairman to do so. While watching our day's proceedings and discussions that emanated from you, a number of subjects came up for discussion; some of them were very interesting, instructive; and I must confess that they have been very helpful to me. I do not want to be lengthy on an occasion like this since most of you are very tired. Most of you are accustomed to orations of politicians from several other platforms, and selected leading intellectuals. There are certain matters of agricultural policy in this country, and I must be very careful about the words I speak.

Glancing through the entire proceedings, there are several striking contributions made by scientists and experienced agriculturists like my colleague the Hon. Parliamentary Secretary for Posts and Telecommunications. In regard to the point raised by Mr. A. M. C. Dias, I have myself no experience about milk marketing. I presume the Commissioner of Marketing is here and I am sure he would make a mental note of the difficulties that confront the producers of milk, and I can give you this assurance, that my Minister will spare no efforts in trying to implement the suggestions that arose in regard to dairy farms and the establishment of a Milk Marketing Board in order to give the producer a reasonable price for his milk. In fact some of those matters were already engaging his attention.

The second item that had a lot of support from this House was in regard to lack of pasture. My friend Mr. Sivapalan was a habitual critic of the pasture policy of Government when he was in Parliament last time, including my friend Gate Mudaliyar Kariapper who was member for Kalmunai and now Chairman of a Town Council. Of course it is very interesting to see the Chairman of a Town Council pleading for

the village cattle. As the lack of pasture has been very forcibly brought up from time to time, it has been accepted by Government, and I remember in 1951 the Rt. Hon'ble D. S. Senanayake and myself went into the question and accepted the position and I can say that every effort will be made to give effect to a plan for the solution of the pasture problem. One of our most senior members, Gate Mudaliyar Wickremaratne, has suggested that we must have five to ten thousand acres of pasture in the Polonnaruwa area. I am very happy to inform him that already the Director of Agriculture has acted upon that suggestion, and in the Tamankaduwa district alone an extent of about 10,000 acres would be set apart for pastures in order to meet the present situation. (Applause.)

Another point was raised by a member, namely, lack of a planned programme for the development of animal husbandry and allied subjects. This has been very forcibly, in his own natural way, brought about by Mr. Kirthiratne who wanted to see a reduction in the imports of eggs, goats, and poultry. I can assure you Hon'ble members that Sir Oliver Goonetilleke is tackling this matter in the O. E. G. method of doing things as it is said. (Applause.) I do not think a day passes without his giving much thought to such important matters like increasing the production of poultry, eggs, and other allied subjects. In the sphere of poultry, I distinctly remember my Minister giving directions to the Permanent Secretary asking that goat centres be established in various parts of the Island with the definite purpose of eliminating this unnecessary and unwanted import of goats into this Island from South India. I am sure that the problem, with your co-operation, can be surmounted.

The other point was a matter which was connected with the separation of the Veterinary Department from the Agricultural Department. Of course this is a matter of high Government policy and I am not competent to give an authoritative statement on it. Of course the sponsor of this resolution has already indicated the reason why there should be a separation of the two departments, and I will not be surprised if for that very reason the suggestion is not taken up. But before the matter is taken up, it is the duty of the Government to listen to the views of the head of the department concerned, and all aspects of the question will be very carefully examined and your point of view will be carefully considered. I can give you that assurance. As all of you are aware, formerly the Department of Land Development attended to the same functions as the Department of Food Production, but we found that in the interests of the progress of this country and the maintenance of a food production drive, a separate department was necessary. The Cabinet did not hesitate to support that view. Of course if it is necessary, this matter too will be considered very carefully. I do not want to touch on all the allied subjects and various other matters that came up in these discussions. To my mind these appear to be the salient points that had been raised by members of this House. On the question of a planned programme, Government can only initiate the policy. I call upon every one of you who are ripe in years and experience to support this drive and initiative of Government by exerting the great influence that you members wield singly, individually, and collectively, in various parts of the Island, to make our position stable, sound, and secure.

Mr. Chairman, I thank you very much for having given me the opportunity of addressing this distinguished gathering. Perhaps with the exception of Dr. Mahadevan and the Director of Food Production, Mr. Idaikkadar, all the others who are assembled here are over 50 years, and your experience is very, very valuable indeed. I must confess that you have great traditions to be proud of, and when compared even to the House of Representatives and the Senate combined, this assembly here is very representative and more directly connected with the agricultural interests of this country, and your opinion will be very valuably regarded by any reasonable body of men in this Island.

Once again, Mr. Chairman, I thank you for having given me this opportunity of addressing the Board."

Chairman: "Gentlemen, before we adjourn, I would like Mr. Weerasooriya who is concerned with the subject of preserving milk to speak to you."

Mr. Weerasooriya thanked the Chairman for allowing him the opportunity to speak to the Board and added that he would like to apologize if they had been misinformed that the bottle of preserved milk (which was shown to all the members) was his work. He said that the bottling had been done in Holland and that it could be kept preserved at least for 5 to 6 years. He added that that process was carried out in almost every country, e.g., U. K., America, &c. He hoped that the problem of marketing milk would be solved if that process proved a success.

In conclusion he said that if anybody was interested he would be prepared to send particulars relating to the process.

Major E. C. de Fonseka, commenting on the process of preserving fresh milk in bottles, said that when he was last in England he had occasion to visit the United Dairies where he had seen the process of milk being preserved in bottles. The first thing they had asked him was whether Ceylon could afford such a project. Major Fonseka had informed the Prime Minister about the new way of preserving milk and the Prime Minister had asked him to get in touch with the Minister of Agriculture and Food. He said that the Prime Minister was very interested in the matter of preserving milk. He remarked that during his visit to the Milk Marketing Board at Thames Ditton, he had seen Mr. Weerasooriya's name in the visitors' book.

Mr. Spencer Schrader also commented on the method of preserving milk and said that from 1920 onwards he had sterilized milk and had kept some for more than a year. He had also the honour of supplying 300 pints of the milk for the use of the Duke of Windsor when he, as Prince of Wales, came to Ceylon in the "Renown".

Finally the Chairman thanked the Parliamentary Secretary and all others who were present at the meeting, and the proceedings terminated at 5.30 p.m.

M. SIVANATHAN,
Secretary,
Central Board of Agriculture.

Tea Research Institute

Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon held at the Office of the Planters' Association of Ceylon, 113, Steuart Place, Colombo, on Friday, July 17, 1953, at 2.30 p.m.

Present.—Mr. R. C. Scott, C.B.E. (in the Chair) ; Messrs. H. S. Hurst ; B. C. V. Weeks ; G. K. Newton ; W. H. Attfield ; W. Neal de Alwis, J.P., U.M. ; Errol Jayawickreme, J.P., U.M. ; D. E. Hettiarachchi, J.P., U.M. ; A. D. McLeod ; W. R. Vander Kiste ; C. Dymoke Green ; Dr. A. W. R. Joachim, M.B.E. ; and J. Lamb (Secretary).

1. Notice convening the Meeting was read.

A letter regretting inability to be present had been received from Mr. V. G. W. Ratnayake, M.B.E., M.P.

2. Minutes of the Meeting of the Board held on April 1, 1953

The minutes were confirmed.

3. Membership of the Board and Committees

(*a*) BOARD

The Chairman welcomed Mr. B. C. V. Weeks to his first meeting of the Board.

(*b*) ESTATE AND EXPERIMENTAL SUB-COMMITTEE

It was reported that:

(i) Mr. B. C. V. Weeks had consented to serve on this Committee during Mr. A. J. Dickson's absence.

(ii) Mr. A. S. Hudson had consented to serve in place of Mr. R. Leaning during the latter's absence on leave.

(iii) Mr. S. P. Vytilingam had left the Island on long leave.

(iv) The Committee had recommended that all members of the senior staff of the Institute should be made members of this Committee. Formerly, members of the senior staff with the exception of the Director, Convener, and Superintendent, St. Coombs, were present only on invitation.

4. Minutes of the Meeting of the Estate and Experimental Sub-Committee held on April 19, 1953

The Chairman asked the Board to agree to an expression of thanks to the Directors of the Eastern Produce and Estates Co., Ltd., coupled with the names of Mr. Rettie and Mr. Andrews, for having placed at the Institute's disposal 618 acres on Meddecombra Estate for large scale spraying and dusting experiments.

5. St. Coombs Estate

(*a*) The Chairman reported that Mr. E. S. Rose had assumed duties as Superintendent of St. Coombs Estate on April 15, 1953, relieving Mr. B. D. Garnier, who had acted from March 1.

(*b*) *Visiting Agent's Report dated April 24, 1953.*—This report was accepted by the Board. It was reported that Mr. Newton had again visited St. Coombs Estate on July 10, 1953. Mr. Newton stated that his report was ready for despatch.

6. Tea Research Cess

Letters from the Planters Association of Ceylon (Agency Section), the Low-Country Products Association, and the Ceylon Association in London, supporting the Institute's application for an increase in the cess, were read. The Director stated that copies of these letters had been sent to the Minister of Agriculture and Food.

7. Staff

(*a*) Engineer—Mr. J. Landreth

Reported that Mr. Landreth had resumed duties on May 11, 1953.

(*b*) Assistant Pathologist—Mr. G. D. Austin

A letter conveying the formal notice of Mr. Austin's intention to retire on December 31, 1953, was read by the Director.

8. Any other Business

Small Holdings Advisory Service

It was reported that the headquarters of this service were transferred to 140, Ambegamuwa Road, Gampola, as from June 1, 1953.

The following confirmation of appointments, recommended by a meeting of the Small Holdings Advisory Service Sub-Committee held on the morning of July 17, 1953, were approved:—

(i) Mr. T. B. Ratnayake, as from May 24, 1953.

(ii) Mr. L. Vincent, as from June 1, 1953.

Tea Research Institute of Ceylon,
St. Coombs, Talawakelle.

J. Lamb,
Secretary.

Rubber Research Institute

Minutes of the 121st Meeting of the Rubber Research Board held at the Planters' Association Headquarters, Colombo, at 2.30 p.m. on Monday, July 6, 1953

Present.—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. G. H. Dulling, Mr. W. Herbert de Silva, Mr. R. J. Hartley, Gate Muhandiram Arthur D. S. Jayasinghe, Mr. L. J. de S. Senaviratne, C.C.S. (Deputy Secretary to the Treasury), Mr. J. H. Van Emden (Acting Director), and Mr. C. D. de Fonseka (Administrative Secretary).

An apology for absence was received from Dr. A. W. R. Joachim (Director of Agriculture).

1. Minutes

(*a*) *Confirmation.*—Draft minutes of the meeting held on May 18, 1953, which had been circulated to members, were confirmed and signed by the Chairman.

(*b*) *Matters arising from the Minutes.*—The terms of assistance to be given by the Smallholdings Department to replanters under the Rehabilitation Scheme were considered and defined. The preparation of a publication giving practical information regarding the replanting of rubber was also authorized.

2. Reports and Accounts

Statement of Receipts and Payments for the Quarter ended March 31, 1953, was approved.

3. Staff

(*a*) Changes in staff since the last meeting were reported.

(*b*) *Holiday on June 2.*—It was reported that June 2 had been declared a holiday for the staff and labourers (with pay for the latter) on account of the Coronation of Her Majesty Queen Elizabeth II.

4. Estate and Smallholdings Department Items

(*a*) *Tenders for Buildings.*—It was reported that eight tenders had been received for the construction of an Assistant Staff bungalow and extension of administrative block and botanical laboratories, and that these had been circulated to the Experimental Committee for consideration. An award was made in accordance with the majority recommendation of the Committee.

(*b*) *Latex Centres.*—Correspondence regarding the prices offered by the Latex Corporation, Kalutara, for latex to be purchased from latex centres from August to December, 1953, was considered and it was agreed that the Board could not interfere in the matter.

5. Control of Oidium by Aerial Spraying

Arrangements being made by a certain firm for a large-scale trial of aerial spraying by liquid fungicides in collaboration with the Research Institute were reported. The Institute's participation in the trial was approved.

6. Publications

(*a*) *Cost.*—In view of increased printing costs since the present prices of publications were fixed, it was agreed that publications should be sold at the following prices in future:—

Annual Reports—Rs. 2 per copy.
Quarterly Circulars—Re. 1.25 per copy.
Advisory Circulars—30 cents per copy.

(*b*) Advisory Circular No. 36 was tabled.

7. Rubber Conference

Reported that arrangements were being made for holding a Rubber Conference in Colombo on November 16, 1953.

Mr. Hartley left the meeting at this stage.

8. Bank Account

Agreed that the Institute's main bank account be transferred to the Bank of Ceylon, Colombo.

The meeting then terminated.

Dartonfield,
Agalawatta, July 23, 1953.

C. D. DE FONSEKA,
Administrative Secretary.

NOTIFICATIONS

[*Extract from the "Ceylon Government Gazette" No. 10,524 of May 8, 1953*]

L. D.—B. 13/52.

THE SOIL CONSERVATION ACT, No. 25 OF 1951

ORDER made by the Minister of Agriculture and Food under section 3 of the Soil Conservation Act, No. 25 of 1951.

K. ALVAPILLAI,
Permanent Secretary,
Ministry of Agriculture and Food.

Colombo, May 5, 1953.

Order

The area defined in the Schedule hereto is hereby declared to be an erodible area for the purposes of the Soil Conservation Act, No. 25 of 1951.

SCHEDULE

The area comprising the upper catchment of the Mahaweli river and the Kelani river, in extent 293,700 acres or 459 square miles, and bounded as follows:—

On the North: By a line drawn from the 57th mile-stone on the Colombo-Ginigathene road north-eastwards to the 6th mile-stone on the Nawalapitiya-Ginigathene road, thence eastwards to a point at the centre of the Mahaweli Ganga, thence north-eastwards along the centre line of the said Ganga to the centre of its confluence with the Kotmale Ganga, thence eastwards along the Nuwara Eliya-Kandy District boundary to the Udahewaheta-Kotmale Division boundary, thence along the said boundary to the point of its meeting with the Gannewa Korale-Maturata Korale boundary.

On the East: By a line drawn from the last-mentioned point southwards and south-eastwards along the Udahewaheta-Kotmale Division boundary till it meets the Uda Hewaheta-Four Gravets division boundary, thence along the said boundary to the Pidurutalagala Trig: point, thence southwards to the Conical Hill Trig: point, thence south-eastwards along Central Province-Uva Province boundary till it meets the Uva-Sabaragamuwa Province boundary.

On the South: By a line drawn from the last-mentioned point westwards along the Central Province-Sabaragamuwa Province boundary to Benasamanagala Trig: point.

On the West: By a line drawn from the last-mentioned point northwards along the Sabaragamuwa-Central Province boundary to Uda Laxapanagala Trig: point, thence north-westwards through Bambaragala, Kiripanagala and Pallebage Trig: points to the starting point of the Northern limit of the area.

[*Extract from the "Ceylon Government Gazette" No. 10,560 of August 7, 1953*]

L. D.—B. 13/52.

THE SOIL CONSERVATION ACT, No. 25 OF 1951

REGULATIONS made by the Minister of Agriculture and Food under sections 4, 6 and 9 of the Soil Conservation Act, No. 25 of 1951, and confirmed by the Senate and the House of Representatives.

O. E. GOONETILLEKE,
Minister of Agriculture and Food.

Colombo, August 4, 1953.

Regulations

1. These regulations shall apply to the erodible area defined in the Order made under section 3 of the Act and published in *Gazette* No. 10,524 of May 8, 1953.

2. For the prevention and control of soil erosion, no owner of land cultivated in tea shall, for the purposes of weeding, use or permit the use of—

(*a*) any mattock or mammoty ; or

(*b*) any karandi or ceti with a working edge exceeding two inches and an overall length exceeding eighteen inches.

3. Where an authorized officer is satisfied that any land cultivated in tea is likely to suffer by stream-bank erosion or by earthslip caused by soil erosion, or adjoins eroding waste land under the same ownership, such officer may direct, by notice, that the owner or occupier of such land—

(*a*) shall not plant the portion of the land cultivated in tea specified in the notice, except with cardamoms, bamboos or any seeds or saplings useful solely or mainly for producing timber, fuel or firewood ; or

(*b*) if the land cultivated in tea exceeds three hundred acres, shall not cultivate the portion of that specified in the notice, except by afforestation, so however that an authorized officer shall not direct afforestation to an extent exceeding one-tenth of the extent of the land cultivated in tea.

4. (1) Any authorized officer may, by notice in writing, served on the owner of any land cultivated in tea, direct such owner to carry out any one or more of the measures specified hereunder for the conservation of oil resources:—

(*a*) In any case where the land is not already provided with lateral drains, to cause lock and spill drains to be provided at a gradient of 1 in 120 with a depth of not less than one and a half feet, such drains to be situated at such intervals as may be determined by the authorized officer.

(*b*) In any case where lateral drains are already provided on the land at a gradient steeper than 1 in 120, to cause such drains to be fitted with stone spill-ways adequate to reduce the flow of water in such drains to less than three feet per second.

(*c*) In any case where artificial main drains, otherwise known as nettikanus, are provided on the land, to cause such drains to be fully paved throughout their length or to be fitted with adequate stone spillways to prevent deepening by flood water.

(*d*) In any case where natural main drains on the land are, in the opinion of the authorized officer, scouring extensively, to cause stone check dams to be provided along such drains.

(*e*) In any case where any land cultivated in tea, which exceeds three hundred acres in extent, has been declared by the Director, after considering the results of a survey made under section 2 of the Act, to be unstable, to cause such land to be afforested to such an extent not exceeding one-tenth of the entire extent of the land, as may be specified in the notice.

(*f*) Maintenance of such cover crops as may be selected in that behalf by the authorized officer.

(2) For the purposes of carrying out on any land cultivated in tea, any measures which an owner has been directed by an authorized officer under paragraph (1) to carry out, the owner shall prepare a programme of work to the satisfaction of such officer and it shall be completed within such period as may be agreed upon by such officer and owner.

5. Any authorized officer may, for the purpose of preventing or controlling soil erosion or the conservation of soil resources, by notice in writing served on the owner of any land cultivated in any crop, direct him to carry out any one or more of the measures specified hereunder on such portion of the land as may be specified in the notice:—

(*a*) Measures for the prevention of damage by fire by the cutting and maintenance of fire belts and the appointment of fire watchers.

(*b*) Measures for the prevention of grazing by means of fencing.

(*c*) Measures for planting forest trees, bamboos or other vegetation approved by an authorized officer.

(*d*) Measures for erecting check dams and contour wattling.

6. Any authorized officer may, for the purpose of the training of streams, by notice in writing served on the owner of any land cultivated in any crop, direct him to carry out any one or more of the measures specified hereunder—

(*a*) If natural channels are subject to erosion, to cause them to be provided with adequately fitted dry stone check dams and flank retaining walls.

(*b*) Spill-ways used in connection with irrigation to be so constructed as to direct only such quantity of water as is required for irrigation purposes and as to permit the surplus flood water to be discharged along the natural channel.

7. Where any land, which has been declared by the Director after considering the results of any survey made under section 2 of the Act to be dangerous to life or property, has not been recommended by him for withdrawal from cultivation, the owner of the land shall, on being directed by notice by an authorized officer, observe the following provisions in respect of that land:—

(*a*) The land shall not be cultivated by the owner with any annual crop, unless it has been fully terraced with stone or grass in accordance with directions given for the purpose by an authorized officer;

(*b*) In respect of land already under permanent cultivation with crops or plants other than those specified in paragraph (*c*), the land shall be fully terraced with stone or grass in accordance with directions given for the purpose by an authorized officer;

(*c*) Except in so far as the land is already under permanent cultivation, the land shall not be cultivated with any permanent crop or plant other than such one or more of the following crops or plants as may be approved in that behalf by an authorized officer—

(i) Cardamoms;
(ii) Bamboos;
(iii) Guatemala grass; and
(iv) Plants solely or mainly useful for the production of timber, fuel or firewood;

(*d*) Any other measures specified in any other regulation;

(*e*) In the case of any holding of over five acres, afforestation to an extent not exceeding one-tenth of the extent of the holding, if so required by an authorized officer; and

(*f*) The land shall be demarcated adequately in such manner as an authorized officer may specify by notice.

8. Where—

(*a*) Land cultivated with an unirrigated annual crop, or

(*b*) Land cultivated as a mixed garden.

is declared by an authorized officer to be subject to soil erosion, he may direct the owner of such land, by notice, to carry out the following measures within the period specified in the notice:—

(i) The owner shall cause the land to be provided with dry stone terraced walls at such intervals and of such height and specifications as may be specified in the notice.

(ii) The owner shall cause the land to be provided with drains constructed in accordance with such directions as may be specified in that behalf in the notice.

9. Where land of the following description, that is to say, degraded forest land or patna or land unfit for tea cultivation which has been cleared for food production but has not been so used, is subject to soil erosion, an authorized officer may direct the owner of such land by notice to carry out the following measures in respect of that land within the period specified in the notice:—

(*a*) The owner of the land shall cause the land to be afforested to an extent specified by the authorized officer.

(*b*) The owner shall cause the land to be provided with stone check dams, if so required by the authorized officer.

(*c*) The owner of the land shall provide all afforested areas and forest nurseries with clean fire belts and take such other measures for combating fires as may be specified by the authorized officer.

10. Where the owner of any land has been directed by notice under any of the preceding regulations to observe any provisions or to carry out any measures, he shall observe those provisions or carry out those measures, as the case may be, subject to such conditions as may be specified in the notice.

11. In these regulations, unless the context otherwise requires—

" Act " means the Soil Conservation Act, No. 25 of 1951;

" Authorized officer " means the Director of Agriculture or any officer authorized by him in writing;

" Contour wattling " means the construction of a hedge consisting of plants specified for the purpose by an authorized officer, at intervals of not more than six feet across a slope entrenched with twisted grass ropes;

" Degraded forest " means land under forest in which plant cover is inadequate to prevent erosion or land under forest which has failed to produce a reasonable periodic yield of timber or fuel; and

" Director " means the Director of Agriculture.

[*Extract from the " Ceylon Government Gazette " No. 10,526 of May 15, 1953*]

L. D.—B. 6/29.

THE PLANT PROTECTION ORDINANCE

REGULATION made by the Minister of Agriculture and Food by virtue of the powers vested in him by section 9 of the Plant Protection Ordinance (Chapter 307), as modified by the Proclamation published in *Gazette Extraordinary* No. 9,773 of September 24, 1947.

Colombo, May 13, 1953.

O. E. Goonetilleke,
Minister of Agriculture and Food.

Regulation

The regulations set out in the Schedule to the Plant Protection Ordinance (Chapter 307), as amended by regulation published in *Gazette* No. 10,135 of August 11, 1950, are hereby further amended in Part I thereof as follows:—

1. In regulation 1, by the substitution, for the words " Royal Air Force Station, Negombo ", of the words " Royal Air Force Station, Negombo, or the airport of Kankesanturai ".

2. In regulation 2, in paragraph (1) thereof, by the substitution for sub-paragraph (1) of the following:—

(1) any tomato seed except under the authority of a written permit from the Director of Agriculture ", and

3. In regulation 3, by the substitution, in paragraph (4) thereof, for the words " Royal Air Force Station, Negombo ", of the words " Royal Air Force Station, Negombo, or at the airport of Kankesanturai ".

RETURNS

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES—MONTH ENDED MAY 31, 1953

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to May 31, 1953				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	2	1	—	1	—
	Rabies	15	83	—	83	—	—
Colombo Municipality	Rabies	3	26	—	26	—	—
Quarantine Station	Anthrax	—	11	11	—	—	—
	Pleuro-pneumonia	—	36	36	—	—	—
Northern Province	Foot-and-mouth	199	517	1	—	436	80
	Anthrax	44	44	44	—	—	—
North-Central Province	Foot-and-mouth	30	30	—	—	18	12
North-Western Province	Foot-and-mouth	27	42	—	—	29	13
Central Province	Rabies	4	27	—	27	—	—
	Anthrax	1	1	1	—	—	—
	Buffalo pox	32	32	—	—	—	32
Province of Sabaragamuwa	Rabies	—	1	—	1	—	—
Province of Uva	Rabies	—	1	—	1	—	—
	Piroplasmosis	—	2	—	—	2	—
Eastern Province	Rabies	—	1	—	1	—	—
Southern Province	Rabies	1	7	—	7	—	—

Department of Agriculture,
Peradeniya, Ceylon,
June 29, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES—MONTH ENDED JUNE 30, 1953

Province	Disease	Fresh Cases during the Month	Total Number from the beginning of this Calendar Year to June 30, 1953				Balance ill at end of Month
			Cases	Deaths	Shot	Recoveries	
Western Province	Foot-and-mouth	—	2	1	—	1	—
	Rabies	15	98	—	98	—	—
Colombo Municipality ..	Rabies	8	34	—	34	—	—
Quarantine Station	Anthrax	—	11	11	—	—	—
	Pleuro-pneumonia	—	36	36	—	—	—
Northern Province	Foot-and-mouth	131	648	1	—	594	53
	Anthrax	11	55	55	—	—	—
	Black quarter	15	15	15	—	—	—
North-Central Province ..	Foot-and-mouth	—	30	—	—	30	—
North-Western Province	Foot-and-mouth	—	42	—	—	39	3
	Rabies	1	—	—	1	—	—
Central Province	Rabies	6	33	—	33	—	—
	Anthrax	—	1	1	—	—	—
	Buffalo pox	33	65	—	—	65	—
Province of Sabaragamuwa ..	Rabies	1	2	—	2	—	—
Province of Uva	Rabies	2	3	—	3	—	—
	Piroplasmosis	1	3	—	—	3	—
Eastern Province ..	Rabies	—	1	—	1	—	—
Southern Province ..	Rabies	1	8	—	8	—	—

Department of Agriculture,
Peradeniya, Ceylon,
July 29, 1953.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT—JUNE, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Ampari	—	—	—	—	—	—	—	—	—	—
Anuradhapura	94·7	+4·9	77·9	+1·5	58	84	5·0	0·01	1	— 0·72
Badulla	87·5	+2·2	66·4	+1·0	61	92	5·8	1·55	5	+ 0·01
Batticaloa	93·5	+1·2	78·2	+0·4	68	84	5·4	0·36	5	— 0·53
Colombo	87·0	+1·6	78·4	+1·1	75	86	6·8	9·88	13	+ 1·22
Diyatalawa	78·5	+1·0	64·0	+0·7	66	79	6·4	1·01	13	— 0·95
Galle	84·3	+0·7	78·9	+1·7	81	84	6·3	5·77	16	— 2·67
Hambantota	88·7	+2·4	78·5	+1·7	73	84	6·3	1·47	12	— 0·64
Jaffna ..	87·2	+0·5	81·2	+0·3	79	85	7·0	1·91	3	+ 1·52
Kandy	86·0	—	71·1	—	66	85	6·0	1·99	14	—
Kankesanturai	91·4	—	81·3	—	73	83	6·4	1·06	3	—
Kurunegala	91·2	+4·7	77·1	+1·5	61	82	6·1	1·38	9	— 5·41
Mannar	89·3	+1·1	81·4	+0·8	78	87	7·0	0·10	1	— 0·26
Nuwara Eliya	69·2	+3·7	56·0	+0·3	79	85	6·6	6·28	17	— 4·15
Puttalam	89·9	+3·6	80·0	+0·8	71	85	6·2	0·37	2	— 1·03
Ratmalana	87·0	—	79·8	—	76	85	6·4	10·30	18	+ 1·32
Ratnapura	90·1	+3·5	75·6	+0·9	72	91	6·0	8·25	21	—10·30
Talawakele	74·5	+3·9	60·5	+0·1	86	94	6·0	9·57	17	— 3·71
Trincomalee	94·8	+2·6	79·3	+0·2	59	78	7·0	2·30	4	+ 1·37
Maha Illuppallama ..	94·6	—	77·9	—	58	82	6·6	0·02	1	—

WEATHER SUMMARY—JUNE, 1953

IN June again the rainfall was considerably below normal in the south-western parts, stations in the hill-country which normally receive over 25 inches recording less than half this amount. Consequently, deficits there exceeded 15 inches, the highest being 23.28 inches at Theydon Bois Group, 19.91 inches at Blackwater Estate, 19.47 inches at Watawala, and 18.97 inches at Kenilworth Estate. In the south-western low-country the shortfalls generally ranged from 5 to 10 inches, except in the neighbourhood of Colombo, where, on account of locally heavy rain experienced on the 5th and 6th, there was an excess. Slight excesses also occurred among the Haputale Hills, in Jaffna Peninsula, and scattered in places in the east and the south-east, those among the Haputale Hills exceeding 2 inches.

The biggest monthly totals were found on the south-western slopes of the hills, where the aggregates at several stations exceeded 15 inches, the highest being 20.10 inches at Norton Bridge, 19.24 inches at Watawala, 18.22 inches at Luccombe Estate, 17.72 inches at Abergeldie Group, and 17.57 inches at Kenilworth Estate. Outside this area there was a gradual decrease in rainfall, monthly totals in the south-western low-country amounting to about 5 inches. In the north and the east the rainfall was generally below 2 inches, about 60 stations, mainly in the North-Central Province and neighbourhood, recording no rain at all.

Most of the rain in the south-western parts was experienced during the period 5th to 17th.

There were 9 daily falls over 5 inches, all occurring in the neighbourhood of Colombo on the 5th or 6th, the highest being 6.70 inches at Elie House Reservoir on the 5th.

As rainfall in May was also exceptionally low, the May-June total in 1953 at several stations in the south-western parts was the lowest on record. Among the long-standing stations, the totals of 6.29 inches at Nuwara Eliya and 9.62 inches at Ratnapura were the lowest in 84 years, while 6.49 inches at Kalutara

and 11.97 inches at Labugama were the lowest in 82 and 74 years, respectively. Although the total at Watawala was 21.92 inches, this amount was also the lowest in 42 years, in addition to being below average by as much as 42.53 inches. Other stations which recorded deficits exceeding 40 inches were Carney Estate and Kenilworth Estate.

Warm weather continued during June too, day temperatures being well above normal, particularly at inland stations. Night temperatures were also a little above normal. Trincomalee again recorded a temperature exceeding 100° (100.9° on the 2nd), while the temperature at Anuradhapura rose very close to this figure on the 11th with 99.9°. The lowest temperatures recorded were: 70.8° at Ratnapura on the 24th for a low-country station, and 48.0° at Nuwara Eliya on the 25th for the whole Island. Humidity was below average and cloud amounts above. Wind strength was rather irregular, being appreciably below normal on the north-east coast. The prevailing direction of wind was south-westerly.

Department of Meteorology,
Bullers Road, Colombo 7, July 10, 1953.

D. T. E. Dassanayake,
Director.

METEOROLOGICAL REPORT—JULY, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	89·6	—1·4	74·7	—1·3	67	88	6·4	4·84	13	+ 3·52
Badulla	84·7	—1·5	65·8	+1·7	67	95	6·6	4·53	17	+ 2·36
Batticaloa	90·7	—1·4	76·3	—0·7	70	86	5·8	3·22	13	+ 2·18
Colombo	84·2	—0·6	74·8	—2·2	79	88	7·3	20·82	28	+15·33
Diyatalawa	75·7	—2·3	62·1	—0·5	74	86	6·9	7·90	21	+ 5·94
Galle	81·9	—0·9	74·9	—1·8	82	88	6·9	27·27	30	+20·93
Hambantota	85·0	—2·5	75·4	—0·9	78	86	6·8	8·83	17	+ 6·82
Jaffna	86·4	+0·3	79·8	0	80	85	7·0	0·94	1	+ 0·39
Kankesanturai	89·8	—	79·4	—	71	85	6·7	2·42	4	—
Kandy	80·5	—	69·3	—	75	87	7·0	11·09	26	—
Kurunegala	85·0	—1·3	73·8	—1·4	74	86	7·0	16·78	27	+12·90
Maha Illuppallama ..	88·9	—	74·3	—	70	88	7·2	3·19	15	—
Mannar	88·0	+0·6	79·7	+0·6	77	87	7·0	0·25	2	— 0·10
Nuwara Eliya	64·2	—1·1	55·2	+0·3	88	91	7·4	14·65	28	+ 3·63
Puttalam	86·3	+0·3	77·3	—1·0	76	86	6·5	5·79	15	+ 4·80
Ratnapura	85·0	—1·6	72·7	—1·8	81	93	7·2	24·77	30	+12·00
Ratmalana	84·1	—	76·0	—	79	88	7·0	22·34	28	+16·88
Talawakele	69·0	—1·2	59·2	—0·3	90	91	7·5	14·79	30	+ 1·49
Trincomalee	90·7	—1·8	76·8	—1·3	65	82	6·5	5·44	8	+ 3·71

WEATHER SUMMARY—JULY, 1953

ACTIVE monsoon weather prevailed over the Island in July. In the south-western foot-hills and the adjacent mid-country, rainfall, accompanied by moderate south-westerly winds, was experienced practically every day, a number of stations recording totals over 30 inches, the highest being 50.45 inches at Weweltalawa Estate, 44.62 inches at Yakkatuwa, 42.44 inches at Watawala, 41.53 inches at Pasyala, and 41.29 inches at Kenilworth Estate. In the south-western coastal areas the totals exceeded 20 inches, while in the southern parts of Kurunegala District they ranged from 15 to 20 inches. Outside the south-west quarter

the rainfall was less than 10 inches, least rain (totals below 2 inches) being recorded in Mannar and Jaffna Districts and in the extreme south-east of the Island. A few stations in Mannar District received no rain at all.

In the south-western parts, the rainfall was heaviest from 25th to 28th, while the only dry day was the 16th.

On account of these heavy rains, the rainfall was considerably above normal in the south-western low and mid-country, monthly aggregates at some stations being more than double the average. The greatest excesses were 36.01 inches at Yakkatuwa, 33.25 inches at Weweltalawa Estate, 26.55 inches at Avissawella Hospital, and 26.35 inches at Kanangama Estate. Elsewhere in the south-west the excesses were generally above 10 inches while outside the south-west quarter they were mainly below 5 inches. A few slight deficits occurred in the neighbourhood of Mannar and Pottuvil.

There were 11 daily falls over 5 inches, the highest being 6.20 inches at Gikiyanakanda Estate on the 25th.

Day temperatures were appreciably below normal, except along the north-west coast where they were slightly above. Night temperatures were also mainly below normal. The highest temperature recorded was 97.3° at Batticaloa on the 1st, and the lowest temperatures, 70.2° at Kurunegala on the 6th (for the low-country), and 49.3° at Nuwara Eliya on the 14th (for the whole Island). Day humidity varied from 75 to 90 per cent. in the wet zone and from 65 to 75 per cent. in the dry zone, while night humidity ranged generally from 85 to 95 per cent. Cloud amounts were above normal and the wind strength about normal, the prevailing direction of wind being south-westerly.

Department of Meteorology,
Bullers Road, Colombo 7, August 11, 1953.

D. T. E. Dassanayake,
Director.

METEOROLOGICAL REPORT—AUGUST, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·6	+1·2	75·6	0	64	88	5·2	0·79	5	— 0·83
Badulla	86·5	+0·4	64·5	+0·1	62	91	5·7	2·33	5	— 0·87
Batticaloa	91·4	+0·9	76·5	0	71	86	3·7	2·54	4	+ 0·59
Colombo	85·8	+0·9	77·9	+0·9	78	82	6·2	1·84	16	— 2·19
Diyatalawa	78·6	+0·7	62·3	+0·6	63	81	5·8	3·48	8	+ 0·36
Galle	83·5	+0·9	77·6	+0·9	80	84	5·2	2·88	20	— 3·26
Hambantota	87·1	+0·1	76·4	+0·3	76	88	5·4	0·16	4	— 1·28
Jaffna	87·3	+1·3	80·1	+0·8	77	85	7·2	1·64	1	+ 0·53
Kankesanturai	90·4	—	79·9	—	70	85	6·4	0·75	4	—
Kandy	83·1	—	69·7	—	70	87	5·7	2·56	13	—
Kurunegala	87·8	+1·0	75·6	+0·7	66	82	5·8	1·46	12	— 2·16
Maha Illuppallama ..	91·4	—	75·1	—	64	86	6·4	2·55	8	—
Mannar	88·7	+1·3	79·9	+1·3	76	85	6·3	0	0	— 0·66
Nuwara Eliya	67·7	+1·6	54·8	+0·5	81	88	6·7	2·96	16	— 4·55
Puttalam	88·4	+2·0	78·8	+0·9	71	84	5·9	0	0	— 0·65
Ratnapura	88·6	+1·9	73·9	—0·4	71	93	6·0	5·85	21	— 5·54
Ratmalana	86·5	—	78·9	—	72	80	6·0	2·04	13	— 1·44
Talawakele	72·3	+1·3	59·3	+0·1	86	94	6·6	5·67	20	— 4·41
Trincomalee	92·1	—0·1	77·8	+0·5	63	80	5·8	5·92	6	+ 2·31

WEATHER SUMMARY—AUGUST, 1953

ALTHOUGH monsoon weather prevailed during August, the winds were generally dry. Consequently, the rainfall was considerably below normal in the south-western parts, the totals recorded being less than half the average. The greater deficits were of the order of 10 to 15 inches, and occurred in the hill-country, including 15.45 inches at Norton Bridge, 15.02 inches at Watawala, 14.35 inches at Hapugastenna Estate, and 13.60 inches at Kenilworth Estate. In the south-western coastal areas the deficits ranged from 2 to 5 inches. In the north and the east, on account of evening thunder activity experienced on a few days, mainly between the 24th and 28th, rainfall was above normal at several stations, the biggest excesses being 5.38 inches at Ihala Hammillewa, 3.47 inches at Valaichenai, and 3.24 inches at Iranaimadu.

Heaviest rain occurred in the south-western hill-country, but the monthly totals did not exceed 15 inches, the highest being 14.08 inches at Carney Estate, 12.20 inches at Wewelta1awa Estate, 11.91 inches at Kenilworth Estate, 11.53 inches at Pasyala, and 11.72 inches at Norton Bridge. Elsewhere over the Island, the rainfall was mainly below 2 inches, except in parts of Anuradhapura and Trincomalee Districts and among the Uva hills, where more rain was experienced as a result of thunder activity. Practically no rain was recorded in Puttalam and Mannar Districts. In Mannar District, the consequent drought conditions were acute, as this was the fourth successive month with little or no rain.

There were no daily falls over 5 inches.

Temperatures were above normal both by day and night, being appreciably so by day. The highest temperature recorded was 97.4°F. at Anuradhapura on the 6th, and the lowest temperature 70.3°F. at Maha Illuppallama on the 8th. (for low-country), and 49.6°F. at Nuwara Eliya on the 6th (for the whole Island). Day humidity ranged from 75 to 85 per cent. in the wet zone and from 60 to 75 per cent. in the dry zone, while night humidity ranged from 80 to 95 per cent. generally. Cloud amounts were a little above average and the wind strength about average, the prevailing direction of wind being south-westerly.

Department of Meteorology,
Bullers Road, Colombo 7, September 9, 1953.

D. T. E. DASSANAYAKE,
Director.

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The Tropical Agriculturist

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The Tropical Agriculturist

Vol. CIX – No. 4 October to December, 1953

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EDITORIAL

The Milk Board

THE recent enactment of the Milk Board Act marks the beginning of a new era in the chequered progress of the dairy industry of the Island and portends well for its future. It is well-known that the consumption of milk in the country is deplorably low and considerably below the requirements of minimum nutritional standards. The reason for this is mainly the absence of a well-organized dairy industry, resulting in the low production and high price of milk, its unreliable quality, adulteration being common, and the lack of adequate facilities for the collection and distribution of even the comparatively small amount of milk produced. Low consumption is also due to prejudice against its use in the diet of many village communities. This prejudice is, however, being rapidly counteracted by the health and education authorities, and through the operation, since 1944, of milk-feeding centres all over the Island where free milk is distributed to pre-school children.

It should, however, be pointed out that efforts have been made in recent years to promote the production and marketing of milk both by co-operative societies and by private dairymen. Following on the publication in 1944 of the valuable report of the Milk Committee appointed by the Minister of Health under the Chairmanship of Dr. W. G. Wickremasinghe, the then Director of Medical and Sanitary Services, and the inauguration of a network of milk-feeding centres, a stimulus was given to the formation of additional co-operative dairy societies, only a few of which were then in existence. These societies were formed for the purpose of securing marketing facilities and a fair price for the milk produced by their members. Subsequently, Co-operative Milk Unions were established in Colombo and Jaffna with the object of promoting the interests of the co-operative dairy societies and, at the same time, of making available to the consumer milk at a reasonable price. The Colombo Co-operative Milk Union now supplies about 7,000 pints of milk a day to institutions and private individuals in the city at the popular price of 55 cents per pint. With the assistance of Government, it is now engaged in erecting a Central Depot where modern dairy equipment for the collection, testing, processing, and distribution of milk will be installed. Meantime, the 52 registered Colombo dairies continue to furnish the major quantity of the city's milk supply, though the owners have been advised that their removal from the city has now become necessary.

The Department of Agriculture has also played its part in the milk production drive in the country by contributing substantially to the milk supplies of hospitals and milk-feeding centres. Last year over 420,000 gallons of cow milk and 110,000 gallons of buffalo milk were supplied from our farms at rates varying from 35 cents to 52½ cents per pint. It has also organized Livestock Production

Societies in various parts of the country to foster the production of milk and other livestock products. Recently it has initiated a scheme for the marketing of milk produced by villagers in the Tamankaduwa District. Under this scheme milk is bought from producers at a price of 25 cents per pint at collecting centres in the village—a figure perhaps twice that obtained by them previously—tested, bulked, pasteurized, and railed to the Colombo Co-operative Depot for distribution.

A few private individuals and Companies have also established dairy farms with commendable enterprise, and are thereby adding to the supplies of good milk in the country. On some coconut estates, many of which are particularly suited for dairy farming, milch cattle are kept; but more frequently than not the milk has to be disposed of at very low prices locally because of a lack of transport facilities. Without, therefore, an authority that would hold itself responsible for organizing milk production and marketing on a national scale, there could at best be only a very limited and sporadic increase in the supplies of the commodity, for two of the greatest incentives to production are an assured outlet and an economic price to the producer. This was the view of the Wickremasinghe Milk Committee, which accordingly strongly recommended the creation of a Milk Board.

A similar situation in regard to milk supplies existed in the city of Bombay before 1944. This was pointedly referred to in the reports of Mr. R. A. Pepperall, Secretary, Milk Marketing Board, U. K. in 1944 on " The Dairy Industry of India " and Mr. D. N. Khurody, Milk Commissioner, Bombay in 1940 on the " Marketing of Milk in India and Burma ". As a result of these reports, what is now popularly known as the Bombay Milk Scheme was finally inaugurated in 1949 though a start had been made in 1945. The Aarey Milk Colony has shown what planned action, strongly backed by authority, can achieve in the field of milk production. The Bombay scheme now handles over 30,000 gallons of milk a day, which it distributes in the city and suburbs from more than 700 centres.

Reverting to the subject of the establishment of a Milk Board in Ceylon, it should be mentioned that the idea found favour with the then Minister dealing with the question, but, owing to changes in Government personnel and more pressing matters requiring its attention, the bill was only recently presented to Parliament. It is gratifying to record that it received the fullest support of all sections of both Houses. The bill is " designed to establish a Board to carry out the task of regulating the production and marketing of milk by (*a*) establishing Milk Production Centres, (*b*) organizing Milk Distribution Centres, (*c*) fixing legal standards of milk, (*d*) the control of prices, (*e*) supervising the conditions under which milk is produced in order to guarantee its purity, and (*f*) generally granting effective assistance for the organization of the milk production and distribution services by local bodies, co-operative societies, &c." Owing to its fundamental importance the bill is reproduced in full in this issue of *The Tropical Agriculturist* and calls for careful study by all those connected in any way with the dairy industry. It is all-comprehensive in its content and scope, and lays a firm foundation for the establishment of a vigorous and *prosperous national* industry—*national* because of its

far-reaching effects on the health and well-being of the younger generation of Ceylonese, and *prosperous* because dairy farming undertaken on sound lines cannot but be productive of profits if organized marketing facilities are provided.

The task awaiting the members of the Milk Board shortly to be formed will be no light one, but they could rest assured that in this they would receive the fullest support and co-operation of all the authorities concerned and of every patriotic citizen of Lanka.

CORRECTION

Page 37 of *The Tropical Agriculturist*—January-March, 1953—
" 0.04% gamma BHC " *to be substituted by* " 0.24% gamma BHC ".

Dairy Economy in Ceylon under Present Conditions of Production

A. V. ANKER-LADEFOGED

Introduction

AS a rule nobody would or could be expected to take up any business enterprise which is not likely to be an economically sound commercial undertaking. Therefore when considering the insignificant role played by the dairy industry in this country one might in the first instance come to the conclusion that this is mainly due to the fact that milk production is not economic under prevailing conditions, as otherwise more activity in this field of agriculture should be expected. But if one goes a step further and compares conditions for milk production here with those found in some of the more advanced dairy countries, it would be found that there is enough evidence to show that dairying could be made a good way of earning a living if properly organized and integrated with other agricultural activities.

The desirability of developing a dairy industry in the country cannot be questioned. From a national point of view such a development is not only fully justified, but also very essential in order to meet the very severe shortage of liquid milk and dairy products in the human diet, and also because the fertility of Ceylon's soils cannot be maintained if livestock, especially cattle and buffaloes, are not more incorporated into the present system of farming. There are more reasons which could be mentioned all favouring the development of this industry and mixed systems of farming, but I shall in this paper confine myself to the more commercial aspects of milk production and thereby, I hope, help to convince the individual farmers that, viewed from their stand point, this industry is economically fully justified.

It is well known that there are several adverse conditions in this country, which tend to discourage the development of dairying. First of all there is the fact that the climatic conditions in Ceylon as a whole are unfavourable for the maintenance of high yielding pure-bred stock of European breeds and secondly that the indigenous cattle and buffalo population are extremely poor producers. Many failures have been experienced in tropical countries, including Ceylon, where attempts have been made to transplant high-producing European stock, and particularly specialized dairy stock, to areas where the environmental conditions differ materially from those in their native home or from other places where they have performed satisfactorily. In recent years, however, the superior heat-regulating ability of Zebu cattle has been fully realized and the trends in most tropical countries is now to utilize Zebu cattle or cross-bred stock, the latter having been found to be intermediate in respect of tolerance to tropical environments.

It will take several decades of work before the average level of production from Zebu cattle and crossbreds will reach standards comparable to those in advanced dairy countries where European stock are kept, but there is evidence that it will be the only way by which the problem can be efficiently and economically tackled. The Department of Agriculture

has already initiated breeding programmes on these lines and one farm is devoted especially to the improvement of the local Sinhala cattle. These breeding programmes and experiments will not only provide useful data for the formulation of the Island's long-term breeding policy, but will also be a valuable contribution to livestock work in the tropics in general.

Cattle breeding, however, is a very slow process and the improvements indicated cannot be expected to solve *to-day's* problem of milk production. In this connection it should be remembered, that while the importance of carefully-planned breeding cannot be over emphasized, the nutritional aspects of dairy cattle are equally important and in this field breeders of cattle and buffaloes in Ceylon would be able to bring about vast and immediate improvements. The position to-day is that not only is there a very small proportion of the cow population utilized for milk production, but the majority of the animals are not looked after at all. Those looked after well are nurtured to a large extent on purchased foods which naturally must result in a high cost of production. Cattle breeders are now fortunate in that good stud bulls are available and a general improvement of the cattle population need not be very far off if use is made of these bulls, and these alone. But this will result in no improvement in regard to productivity if the general level of feeding throughout the country is not going to be very considerably improved.

Although the present rather poor stock available will effect the economics of dairying to a great extent and thus causes a further obstacle to those who embark on milk production as a business enterprise, it should not prevent people with initiative making an economic success of it. The cattle breeders in this country should not merely sit back and wait for better animals, but along with improvement of stock make full use of existing facilities for milk production. In regard to the more specialized dairies, there is a good number of stock available (mainly crossbreds) which could be used for this purpose and this type of stock could rapidly be increased if dairy owners would bring to a stop the enormous wastage of calf life which at present is far too common. In regard to rural areas cattle are numerous in nearly all Ceylon villages, yet it is the rare exception to see a cow being milked. A common explanation for this is that the cows available give so little milk that they are not worth milking, but this explanation cannot be accepted in general as many of these cows with better care and proper feeding could yield a quantity of milk which would be sufficient for most families.

Economic Problems

Turning to the actual problems of economy the factors deciding the final result of production are—

(1) Demand and price of milk and surplus stock.

(2) Cost of production, inclusive of replacement of herds.

Mention has already been made of the fact that there is a ready demand for milk of good quality, or rather a severe shortage, and this is likely to be so for many years ahead. As regards the price of milk a good deal of variation exists throughout the country—the

maximum prices being paid in urban areas, particularly in the Colombo area, and the lowest in rural districts where very little milk is produced and the marketing has not yet been organized to any extent. For the country as a whole, a price varying from 35-40 cents per pint (Rs. 2.80-Rs. 3.20 per gallon) for non-pasteurised milk of good quality, may be considered as representing the price most producers would be able to obtain. When compared with prices paid for milk to producers in other countries it is evident that the above price is very favourable:

	Rs. c.	
Price per gallon in Ceylon	3 20	approx.
,, ,, ,, U. K.	1 45	,,
,, ,, ,, Sweden	1 35	,,
,, ,, ,, Australia	1 30	,,
,, ,, ,, South Africa ..	1 15	,,
,, ,, ,, U. S. A.	1 65	,,
,, ,, ,, Denmark	1 28	,,

On the average, producers in Ceylon are paid two and a half times as much as in the above mentioned countries which may be considered representative of some dairy regions.

While the disposal of milk is entirely a problem of getting the marketing facilities, &c., developed, the position in regard to disposal of surplus stock is different. The demand for meat of cattle and buffaloes is very limited and the prices which can be obtained for culled cows, undesirable male stock, and such animals which have passed their productive period are therefore very low, compared with prices paid in some countries with a developed dairy industry. This disadvantage, however, is to some extent counteracted by the fact that in Ceylon a fairly good demand exists for draught bullocks and buffalo males for paddy cultivation, unlike in the other countries mentioned.

		Rs. c.	
Average price for beef in Ceylon	= approximately	0 27	per lb. live weight
,, ,, ,, ,, U. S. A.	= ,,	0 95	,, ,,
,, ,, ,, ,, Denmark	= ,,	0 72	,, ,,
,, ,, ,, ,, U. K.	= ,,	0 80	,, ,,

There is practically no market for veal or meat of extra good quality in Ceylon and no system of grading meat has been introduced as a consequence thereof. It will be seen from the above list of prices that in the other countries prices of beef are so high that culled cows and old animals can normally be disposed of at prices which bring in enough money to pay for their replacement, or at least a very good part of this cost, whereas in Ceylon this is not the case. The dairy farmer in this country is therefore faced with another drawback in his economy to which more mention will be made under " replacement cost ". There is yet another income which arises from dairying: cattle manure, the value of which is difficult to assess as it is only in rare cases that it is sold from dairy farms. Cattle manure has a special high value on such farms where, besides dairying, intensive systems

of agricultural production are adopted. Just as the utilization of nourishing foods by live-stock has become a matter of prime importance, so the question of fertilizing the soil by animal manure has become a fundamental problem.

Factors Determining Cost of Production

The cost of production on broad lines is determined by the following:—

(1) *Level of production or average production per cow.*

(2) *Intensity of feeding and food costs, viz. :—*

(*a*) *home-grown foods,*

(*b*) *purchased foods.*

(3) *Cost of labour.*

(4) *Cost of replacement (including wastage by death).*

(5) *Overhead and miscellaneous costs.*

High average production per cow in a herd tends to increase the profit as good cows are more economic converters of feeding stuffs into milk than low yielders. This is because a very considerable part of the food consumed by dairy stock is utilized for body maintenance, heat production, &c., and this requirement for maintenance varies only according to body size, but is the same for low and high yielding cows. This therefore means that each unit of milk produced from a high producer will be cheaper than the unit produced by low yielders. For instance for a cow producing about 250 gallons of milk with 4 per cent. fat in a year only about 35 per cent. of the ration will actually be utilized for milk production while the other 65 per cent. of the ration will be used for maintaining her body ; whereas the figures for a cow producing about 850 gallons of milk per year of the same quality would be approximately 65 per cent. and 35 per cent. respectively. The figures given below clearly illustrate the greater economy derived at by an increased production per cow.

Cows (same live weight 1,100 lb.)	*I*	*II*	*III*	*IV*	*V*
Milk production per year in lb.	4,400	6,600	8,800	11,000	13,200
Food units fed per year	2,100	2,500	2,900	3,300	3,700
Milk production per food unit	2·09	2·64	3·03	3·34	3·56
Increase in return per food unit	—	0·55	0·39	0·31	0·22

(By Nannenson Sweden)

The figures demonstrate how the production of milk per food unit fed increases from 2.09 to 3.56 lb., it is, therefore, quite evident that it is much more economical to keep very good cows than low-producing ones, but this, however, does not of necessity mean

that low producers are always uneconomical animals to keep. Whether it will pay or not to keep cows of a low level of production is entirely determined by the conditions of production in the particular area or country. Most of the milking cows available in Ceylon would certainly be considered uneconomic animals in advanced dairy countries, but under our conditions of production they could, if well looked after, bring in a good profit.

2. Food cost is the greatest single item in the cost of producing milk and the profit or loss that accrues from milk production is, to a very large extent, determined by the cost and efficiency of the ration. Each cow has a definite hereditary maximum producing capacity. The extent to which her production reaches this capacity is determined by the quantity and quality of the food given. It is profitable to feed each cow so that she can approach the highest production of which she is capable, but the use of additional feed would be wasteful, as it would result in accumulating unnecessary body fat that would *further* increase the food required for maintenance. Thus milk yield response to extra food reacts in much the same way as crop yields when dressed with extra fertilizers. The first additional pound of concentrates produces more extra milk than the second or subsequent ones, and eventually the rations may be increased to a stage where the response to extra food is negligible. The table above shows that the return per extra food unit fed declines as milk production increases. When milk production increases from 4,400 to 6,600 lb. the gain per extra feed unit is 0.55 lb. but with the same increase from 11,000 to 13,000 lb. it is only 0.22 lb. Furthermore, it must be stressed that for very high production of milk and increasing part of the feed must be of top quality (concentrated food rich in protein), and this would mean that the actual gain by extra feed would be less than indicated above as the average cost per unit fed would also increase. The above circumstances are only applicable in such cases where the ration is well computed furnishing the cow with all her nutritional requirements. If a ration is badly computed, e.g., if it lacks in one or more of the important components, which is often the case particularly in regard to proteins, then the result is a poor milk return and high cost of production. Such bad feeding technique is very common in this country, chiefly because cheap feeding is the main consideration, and this neglect of the cows requirements leads invariably to poor economy in dairying. Turning again to the question of intensity of feeding, it should always be borne in mind that the production optimum and the economic optimum are not always reached at the same level of feeding. The optimum production of milk will as a rule be reached only after a certain amount of over-feeding has taken place. This is for the reason that though the return of milk obtained from each additional unit of the *production ration* fed reaches a point where it starts declining, as shown in the table above, the return per additional unit of *total ration* fed, viz., the maintenance and production ration togther, will continue to increase to a certain point beyond this limit, as the maintenance ration remains the same. The production optimum is the point where the maximum return of milk is obtained from one unit of the *total ration* fed, while the economic optimum of production can be either higher or lower depending on current prices of food and milk, &c. The economic optimum will be at the point where for the last rupee spent one gets exactly one rupee's worth of product back. Thus if the price of milk is very high compared with the cost of food and other expenses involved, then it pays to adopt heavy feeding, while if the opposite is the case, the intensity of feeding should be adjusted accordingly ; but under-feeding should, however, never be done as it will

always pay better to utilize the production capacity of the cows fully rather than to reduce the number of cows during such times when very low prices of milk prevail. The adequate but economical feeding of each dairy cow in the herd is probably the dairy farmer's greatest managerial problem. Its satisfactory solution is lacking in most unprofitable dairy enterprises.

Feed costs for both purchased and farm-grown food is from 60-80 per cent. of the total expenses per cow. A study and analysis of feeding practices and costs is the dairy farmer's most important means for increasing his profit by either (1) reducing costs without reducing income, or (2) considerably increasing his income without greatly increasing his costs.

In livestock feeding maximum use should be made of the lowest-cost nutrients and minimum use of highest-cost nutrients. The lowest-cost nutrients are roughages grown on the farm fed fresh or as hay and silage. Of all farm-grown food pasture is the most economical source of nutrients for dairy herds, as the cows walk to the fields and do their own foraging thus saving labour and equipment costs. The contribution of roughages to rations for dairy cows in Ceylon is, however, far too small. Most roughages fed are of unsatisfactory quality, consisting mainly of coarse fodder grasses most of which are harvested at too mature an age and therefore providing fodder which has only little nutritive value for milk production. There is in this country immense scope for that of grass land and fodder production (improvement and expansion). Appropriate measures in this field would not only bring about considerably increased, but also a much cheaper production of milk. Furthermore, such crops would fit well into a rotation with other crops including paddy. The failure on the part of the dairy farmers to grow sufficient and good quality roughage (including pasture) for feeding their stock is one of the main causes for the very poor results obtained in most dairy farms and holdings.

The circumstances indicated above should, however, not lead to the conclusion that in case such development takes place purchased concentrates could be done away with entirely. It is true that very good yields can be obtained by feeding roughage and pasture alone, but this calls for a very high quality of roughage and considerable skill in management. As a rule the most economical production of milk is obtained when purchased concentrated foods are used for supplementing the home-grown food. The main purpose of feeding concentrates is to provide each cow with nutrients adequate in quantity and quality to maintain production at the maximum level of which the cow is capable. Concentrated food supply ingredients that may be lacking in the other foodstuffs and the proportion of concentrated foods in the ration should always be such that it also ensures efficient utilization of the roughage fed. Whether it is economical or not to feed more concentrated food than is actually required for balancing the ration depends entirely on the prices of (1) milk, and (2) concentrates. Under favourable conditions it might often be economical to make intensive use of concentrated feeds. Ceylon is fortunate in that good concentrated food is available at a very reasonable price. I have in mind in particular, coconut cake, which is produced in large quantities locally. Coconut cake or poonac is an excellent cattle food which may safely constitute about 70-80 per cent. of the concentrate mixture as both in regard to proteins and starch, it is well balanced for milk production.

When a large percentage of coconut cake is used the remainder of the ration, 20-30 per cent. could be made up of other locally-produced ingredients such as fish meal, rice bran, grains and pulses all of which are likely to be produced in the future in increasing amounts. Ceylon need not therefore look to other countries for cattle food if good use is made of locally-produced concentrates and adequate amount of pasturage and roughages are fed. In spite of this fact, it is very common to hear complaints about the high prices of cattle food and that because of this the production of milk is not an economical proposition. The figures given below should, however, help to convince dairymen that prices here are very low, and if milk cannot be produced profitably in spite of a such favourable relationship between the prices of concentrates and of milk then the reason for this is most likely because not enough attention has been devoted to the production of farm-grown fodder. I am not here referring to the congested town dairies, but to others which are well placed for land.

Approximate average prices for concentrates (mixtures) for dairy cattle in various countries in relation to the price of milk are as follows:—

	Per lb. *Rs. c.*	
U. K. ..	0 24	One gallon of milk pays for 6 lb. concentrates
Sweden ..	0 22	„ „ „ „ „ „ 6 „ „
U. S. A. ..	0 21	„ „ „ „ „ „ $7\frac{2}{3}$ „ „
Denmark ..	0 22	„ „ „ „ „ „ $5\frac{2}{3}$ „ „
South Africa ..	0 15	„ „ „ „ „ „ $7\frac{1}{2}$ „ „
Ceylon ..	0 12	„ „ „ „ „ „ 25 „ „

3. There is no statistical data available in Ceylon to show the labour required for dairy farming, but there is no doubt that considerably more labour is used here than in more advanced dairy countries. Labour saving equipment has not yet been brought into use, except in a very few cases, neither is it likely to be so for some years to come as the present wages paid in Ceylon do not encourage such development. In this connection it might be mentioned that machine-milking would be more expensive than hand-milking under present conditions and that mechanical milking does not offer other advantages which justify its introduction as yet. Labour is not at present a limiting factor in the Island's dairy economy in contrast to many other countries where this presents many difficulties.

Labour is readily available here and the wages comparatively low:

In U. K. one gallon milk pays for	$\frac{2}{3}$	hours wages approx.
„ Sweden „ „	$\frac{2}{3}$	„ „
„ U. S. A. „ „	$\frac{1}{2}$	„ „
„ Denmark „ „	$\frac{2}{3}$	„ „
„ S. Africa „ „	$2\frac{1}{3}$	„ „
„ Ceylon „ „	10	„ „

If we consider a labourer's wages for the year in terms of lb. milk sold at prices prevailing in the particular country then it would work out thus:

In the U. K.	35,000 lb.	of milk	are	required	to	pay	one	year's wages for a labourer
„ „ Denmark	38,000 „	„	„	„	„	„	„	„
„ „ U. S. A.	58,000 „	„	„	„	„	„	„	„
„ „ Sweden	38,000 „	„	„	„	„	„	„	„
„ „ Ceylon	3,200 „	„	„	„	„	„	„	„

The average production per cow for instance in Denmark is approximately 8,000 lb. and thus the entire production of 4.6 cows is required for the payment of the wages of a labourer for a year. In Ceylon taking for granted that the average production per cow is 1,100 lb. 3 cows would similarly pay one year's wages for a labourer.

4. The maintenance of a herd of milking cows, at a satisfactory level of production requires the replacement of about one out of five or 20 per cent. of the average number of cows each year. Losses by death (of cows) would as a rule average about 2 per cent. and culling for production and disease will remove the other 18 per cent. These figures will of course vary widely from year to year and from herd to herd, but the above figures are a rough guide to replacement needs. If replacements are purchased as cows, as it happens in some of the town dairies, then the replacement would be much higher probably 30 to 50 per cent.

The yearly cost of replacements is determined by the difference between the cost of rearing or buying the new cow and the price which is obtained for the one sold out, and also by the average number of its productive years in the herd.

$$\text{Replacement cost per year} = \frac{\text{Cost of rearing (or purchase)—sale price of old cows}}{\text{Number of years in production.}}$$

But to the above must also be added wastage by death of young stock intended for replacement.

It is common in Ceylon for dairy farmers to provide their own replacements by rearing a sufficient number of heifers, but in some cases people prefer to buy their replacements at a comparatively high cost rather than take the trouble of bringing up calves born on the farm. The latter system is, in this country, causing severe losses of potentialities of milking stock as the mortality among calves in such dairies is extremely high.

It is true that the cost of rearing heifers up to milking age is high and that this expenditure is a heavy item in dairying. But it is one on which too much saving should not be effected as inadequate feeding during the growing period often creates weakness which later tend to reduce the milking capacity and frequently paves the way for a breakdown if the animal is subjected to any serious strain. In stead efforts should be made to bring up heifers so that they come into production at an early age. It makes a great deal difference to the economy whether heifers start producing when $2\frac{1}{2}$ years or $3\frac{1}{2}$-$4\frac{1}{2}$ years old, as is most commonly the case in Ceylon, although there is evidence to show that heifers can reach maturity here if well looked after, as early as in most western countries. It should also be kept in mind that poorly-fed heifers seldom make cows with strong constitution, but far

too often they have to be disposed of after a few years of production. The latter has a very great influence on the economics of dairying as it costs approximately twice as much to produce one gallon of milk from a cow leaving the herd after 2 lactations as from a cow which has given five lactations.

The cost of rearing heifers is considerably lower in Ceylon than in most other countries. In Ceylon, with present prices on cattle food, milk, &c., a heifer can be reared up to maturity for about Rs. 420 (average cost in Government cattle farms) while in the U. K. it costs about Rs. 600 and in the U. S. A. about Rs. 700. The average cost in Ceylon is, however, probably somewhat higher than indicated above, partly due to the high mortality among growing stock and partly because of late maturity due to inadequate feeding. The very low prices obtainable for the cows disposed of make the cost of replacements heavy while in most other countries such disposals tends to balance the cost of replacements.

In connection with replacement costs there is one managerial aspect which needs mention because it is very often neglected here or its importance overlooked. It is very common in Ceylon to find that in a milking herd only 30-50 per cent. of the cows are in milk, while the others are divided into what are called " dry " cows and pregnant cows. Such a state of affairs does not only indicate very poor management, but also results in poor economy. This is brought about by not serving the cows in time and thus prolonging the " dry period " during which they have to be fed although they are not productive. In a well-managed dairy farm there should be only a milking herd and a heavy pregnant herd and on an average 70-80 per cent. of the cows should be in milk. Service of cows at correct time ensures high birth rate and more animals for replacement and sale.

5. Overhead costs of depreciation and interest, &c., are no large items and they seldom have much effect on total costs and financial security. To have good stock and adequate facilities is an advantage, but a dairyman's financial strength can be weakened by heavy liabilities on non-essential facilities. Too much building area, &c., increases labour on maintenance. A small milking barn can accommodate many cows in successive groups, and a lower investment is required for the storage and handling of hay, silage and purchased cattle food when maximum use is made of pastures. Ceylon is fortunate in having such climatic conditions that only very simple and cheap housing is required ; and as regard equipment, &c., the capital investment can also be kept at a low level so long as labour is available at a reasonable price.

Miscellaneous costs comprise items like bull upkeep or stud fees, veterinary fees, medicine, consumable dairy stores (exclusive of cattle food) and other expenses directly chargeable to the dairy herd or necessarily incurred in milk production. Miscellaneous and overhead costs should, under Ceylon conditions, never amount to more than about 10 per cent. of the total cost of milk production and the effect of this group of expenditure items on the final economic result will, therefore, always be very limited.

An aspect of dairy farm organization still to be discussed is that of the size of herd in relation to availability of land. Generally speaking a well-organized dairy farm business is one where herd size is fitted to the amount of feed that can be produced most economically on the farm ; and where labour supply, buildings and equipment are fitted to size of herd.

Roughage production on the farm from both crops and pasture is a very important consideration, since farm grown forage is usually much cheaper than feed purchased and transported. Above all, however, the organization of dairy farming should be adjusted to conditions prevailing in the locality such as: market possibilities, value of land, availability of labour, system of agricultural cropping, producing capacity of available stock, and most important, a proper integration of other activities on the farm or holding if any, viz., paddy cultivation, coconut plantation, &c. The degree of intensity of dairy husbandry should be determined by the above conditions in order that the best possible economic result might be obtained.

In conclusion I should like to stress the importance of good management, as even the best of dairy farms will not be financially successful unless it is well managed. To employ good management practices all the while is the dairyman's safeguard in bad times and an assurance of higher profits in good times.

Summary

1. There is a general tendency in Ceylon to consider dairy farming as of minor importance in the agricultural economy and as an unattractive commercial undertaking. It is shown that this is not justified as dairy farming, even with the rather poor stock available, could be made a profitable business under present conditions of production.

2. The present relationship between food prices, labour cost and milk price is very favourable, but the failure on the part of Ceylon's dairymen to produce sufficient quantities of home-grown fodder accounts for poor economy in many dairy enterprises. There is in Ceylon immense scope for grassland and fodder production, improvement and expansion.

3. The art of management is the most important factor in the success of any dairy farm business.

Agriculture in the Northern Division

S. K. THURAISINGHAM

Geography

THE Northern Division comprises the whole of the Northern Province including the Islands. The Jaffna Peninsula and a group of Islands lying off the west coast form one part, and the mainland consisting of the Karachchi and Pooneryn Tunukkai Divisions of the Jaffna District and the two Districts of Vavuniya and Mannar form the other part. The area of the Province is 3,429 square miles of which 75 square miles are covered by water leaving a land area of 3,354 square miles. Of its total acreage 10.6 per cent. is cultivable. The cultivable paddy lands form 40 per cent., the coconuts 11.5 per cent. and home gardens rotation crops, &c., form 48.5 per cent. of the cultivable area. The Jaffna Peninsula and the Islands are flat. There are no rivers. In many places the sea runs in and forms large lagoons which cut right through the centre and eastern portions of the Peninsula. The southern portion of the Peninsula is sandy and covered by shrub jungle with coconut plantations on the west coast and palmyrah along the east coast. The northern portion, except for scattered patches of rocky land, is almost entirely garden cultivation ; paddy, tobacco, chilli, cereals, &c., are grown. On the other hand, the mainland is covered with jungle which is only broken here and there by cultivation and habitation close to a tank. The Mannar Island is open sandy shrub land. Along the western coast which skirts part of the mainland of the Mannar District, and along the north-eastern coast of the Province, salt marshes alternate with jungle. The major portion of the Vavuniya District is a tableland rising to about 300 feet above sea level, and there are a few rivers which flow only in the North-East Monsoon season.

Rainfall

The rainfall for the Province in 1952 was as follows:—

	Jaffna District		*Vavuniya District*		*Mannar District*	
	Rainfall Inches	*No. of Rainy Days*	*Rainfall Inches*	*No. of Rainy Days*	*Rainfall Inches*	*No. of Rainy Days*
January	4·40	8	6·66	7	4·26	9
February	1·36	3	1·92	1	1·89	3
March	1·85	3	2·42	4	2·14	4
April	2·41	5	4·51	9	3·83	7
May	1·95	3	3·23	5	1·98	4
June	0·40	1	1·07	1	0·33	1
July	0·52	1	1·09	1	0·30	1
August	1·19	3	2·64	3	0·64	2
September	2·36	4	3·67	2	1·13	3
October	9·31	12	8·74	18	7·25	11
November	17·01	18	14·85	12	10·64	17
December	10·88	14	12·47	24	7·67	14
Total	53·64	75	63·07	87	42·06	76

The Northern Province experiences one main Monsoon season, the North-East Monsoon, and little or no rain fall during the South-West Monsoon. Even during the North-East Monsoon season the rainfall is restricted to the three months October to December during which period heavy precipitations of as much as 5 inches and over in a day are not infrequent. Failures of the North-East Monsoon have not been rare, especially in recent years, and these have resulted in total loss of crops grown.

The main cultivation is determined by the rainfall and therefore coincides with the North-East Monsoon season. All rainfed crops are planted at the commencement of the North-East Monsoon season. The annual crops grown are such that they mature at the end of the Monsoon season. Little or no rainfed crops are sown for the South-West Monsoon season. Although the North-East Monsoon cultivation is the major season, yet where ample irrigation water can be had from wells the actual planting or sowing is done with most crops at the tail-end of the Monsoon. It is not often that successful crops are raised with the Monsoon rains which, either due to scarcity or excess, cause some damage to crops in most years. The Jaffna Peninsula and parts of Vavuniya District receive a fair rainfall during the North-East Monsoon ; yet where there are wells with abundant supply of water the cultivators prefer to commence cultivation of crops such as chilli, onions, tobacco and local vegetables towards the tail-end of the season to avoid damage by excess or scarcity of rain.

A major portion, in fact about 80 per cent. of the cultivated area under irrigated paddy in the Northern Province, depends on the water in the minor and major tanks for cultivation. These tanks fill in a normal North-East Monsoon season, and cultivation is undertaken either in anticipation of the tanks filling or after the tanks are full.

The rainfall in normal years should be sufficient to fill a number of tanks which can be restored or are in the process of being restored.

Land, Land Tenure and Capital

The area of land actually taken up for cultivation at one time or other does not total more than 10.25 per cent. of the total area of the Province. On a rough estimate another 40 per cent. of the land can be taken up for cultivation of paddy under irrigation, for dry farming and for cattle raising. The Iranamadu Augmentation Scheme and the restoration of tanks such as Vavunikulam, Akkarayankulam in the Jaffna District, Pavatkulam, Muthainkaddu and Thanimuruppu in the Vavuniya District and the Malwatuoya Scheme in the Mannar District, in addition to restoration of numerous minor tanks now lying in disuse should considerably increase the extent cultivated. Extension of cultivation even under the tanks restored, or whose supplies of water have been increased, tends to be slow due to want of capital.

Government assistance to develop land given out on permits, and the establishment of colonization and village expansion schemes under major and minor tanks, have assisted to a great extent in extending the area under cultivation.

One of the chief drawbacks to increased production and investment of capital on land is the insecurity of tenure. The issue of Crown land on permits, and the non-granting of outright sale permits, have to a great extent withheld capital which otherwise would have been invested on land. Another major reason for non-investment of capital on the land is the high cost of developing. Cheaper and quicker methods should tend to attract capital. The use of high-powered machinery in asweddumizing land for paddy and for reclaiming rocky land in the Jaffna Peninsula should attract capital because of the economic minimum prices guaranteed by Government for products such as paddy, cotton, chilli, onions, &c.

There are very few colonization or village expansion schemes. There is only one colonization scheme in the Jaffna District. With the restoration of minor and major irrigation schemes more colonization and village expansion schemes are under consideration or are in process of being established.

In recent years the organization of Co-operative Production and Sales Societies have assisted the cultivators in obtaining the capital they require for agricultural purposes. Short-term loans are granted by these societies for the purchase of seed for cultivation, for harvesting and marketing, and long-term loans for purchasing equipment such as barbed wire, pumps for irrigation, &c., and for the development of land.

The fixed rent systems of tenure now existing in most parts of the Province are fair and reasonable. However, the insecurity which now exists tends to deter general adoption of improved methods or the improvement of land.

In the Sinhalese D. R. O's Division of Vavuniya South the ancient system of " ande " is still in force.

Area of Holdings

The number of holdings and cultivable extents recorded according to the 1946 Census are as follows:—

	Holdings	*Cultivable Acres*
Jaffna District	210,395 ..	151,384
Vavuniya District	16,050 ..	31,650
Mannar District	14,738 ..	37,535

The cultivable land is largely paddy and the analysis of holdings according to the 1946 Census is as follows:—

	Jaffna District No. of Holdings	*Vavuniya District No. of Holdings*	*Mannar District No. of Holdings*
Total number of holdings ..	57,484 ..	8,258 ..	9,044
Holdings less than ½ acre ..	26,282 ..	240 ..	1,074
Holdings between ½ and 1 acre ..	17,144 ..	1,165 ..	1,331
Holdings between 1 and 2 acres ..	8,699 ..	2,108 ..	2,283
Holdings between 5 and 10 acres ..	727 ..	989 ..	939
Holdings between 10 acres and over ..	478 ..	247 ..	303

Even though the average size of holding owned by each is small in the Vavuniya District and the Mannar District, yet the actual extent cultivated by a cultivator is larger due to the smaller number of persons interested in agriculture. The extra land is obtained on lease. The distribution of the size of holdings given above for Jaffna District is even true of the size of holdings cultivated by a cultivator.

The extents of land cultivated with crops other than paddy are also small in the Jaffna District where intensive forms of cultivation with irrigation from wells is done. The income however is high because of the high yields obtained. These crops are cultivated in the Vavuniya and Mannar Districts on an extensive scale depending on the rains due to the absence of wells for irrigation. As yields under such conditions are poor, larger extents are cultivated to obtain the required income.

Soils

The soils of the cultivated area and of much of the uncultivated land in the Northern Province can be said to be fertile, except for a few tracts scattered throughout the Province which had been selected for cultivation owing to the proximity to their homes by a population which took to agriculture as a part-time occupation such as in Mannar Islands and along the east and west coasts of the Province where fishing is the main occupation.

With a few exceptions the whole of the Northern Province has the red to yellowish-red soils of the dry zone varying in texture from light sandy to heavy loams and contain high proportions of gravel and limestone. These soils respond well to cultivation of annual crops for the first two or three years, but subsequent yields are low. The exceptions, however, are:

(i) The red soils of the Jaffna Peninsula formed from sedimentary limestone, largely calcium carbonate, which vary from light to heavy loams overlying limestone rocks. These soils store a fair proportion of the rainfall that falls on the land.

(ii) The brownish-red soils close to Mullaitivu probably of pleistocene deposits overlying gneiss rock borne from the hills, poor in organic and mineral content.

(iii) Heavy dark clay loams of the Giants Tank area, which are poor in mineral and organic material, but which respond well to deep cultivation and are only suitable for wet cultivation of paddy.

(iv) The characteristic black soil found at Tunukkai which cover an extent of about 16 square miles. The soil resembles the black cotton soils and does not drain well. It is a heavy loam poor in organic and mineral matter.

(v) The calcareous loams found in the Islands. This greyish white calcareous loam comprised of miocene limestone is poor in organic matter and nitrogen.

Special reference has to be made to the reclamation of land in the Jaffna Peninsula and the Islands. A fair portion of the land now under cultivation in the Jaffna Peninsula was rocky land reclaimed in the last century or so. The process involved is long and tedious. The rock which is not in one mass but mixed with soil is removed in small stages by digging by hand and at times by blasting. After the rocks are removed all the rocky materials

and gravel are sifted out and the soil levelled. The cost of reclaiming an acre of land is in the neighbourhood of Rs. 6,000. There is very little land now not cultivated which is free from rocks. The extent that could be reclaimed and utilized for the cultivation of the two commodities, chillies and onions, which are in short supply is about 700 acres. The use of a D/8 Tractor with a ripper may expedite reclamation. This possibility is under investigation.

Population and Labour

The population for the Province is 571,214 persons according to 1953 Census, over 75 per cent. of whom are resident in the Jaffna Peninsula. The following are the figures for the various Districts:—

District	*Area*	*Population*	*Density per Sq. Mile*
Jaffna Peninsula	410¼ sq. miles	414,326	1,009
Jaffna District not including the Islands but excluding the Peninsula ..	554½ ,,	78,058	140
Vavuniya District	1,431½ ,,	35,119	24
Mannar District	957¾ ,,	43,711	45

This uneven distribution is the main cause not only for the cultivated extent being small but also of the extensive methods of cultivation followed in the Vavuniya and Mannar Districts. Where the population is dense small extents of land are cultivated intensively. In the thinly-populated areas where the wants of population are few and the holdings are large there is generally a marked absence of enthusiasm to increase yields.

Scarcity of labour in the thinly-populated areas where there is ample land and abundance of irrigation facilities has, roughly speaking, acted as a deterrent to any form of large-scale investments of capital in agriculture. The present methods adopted in cultivation are unattractive to the youth. There is general dislike to any form of manual labour or to the handling of cattle, especially buffaloes. Mechanical forms of cultivation may prove to be more attractive.

Transport and Marketing

The slow and uncertain transport in the past has been replaced by more efficient motor transport. Except in the remote parts of Mannar and Vavuniya Districts the existing roads have been improved and new roads have been constructed in the Province to enable the producer to market his produce cheaper and more efficiently, so much so that produce is saleable today from the threshing floor. Losses incurred in transport of perishable produce have been reduced to a minimum with the use of motor transport, and the refrigerator van transport under consideration by the Co-operative Department should further reduce loss. The Province in addition to being served well with road transport is also served

efficiently by railway transport. The Jaffna-Colombo and Talaimannar-Colombo main lines pass through the Province, and at every five to ten miles sidings and stations cater for transport of agricultural produce.

Marketing has improved considerably. There are Marketing Department organizations in the three main centres, Jaffna, Vavuniya and Mannar, to assist the villager to market his produce profitably. The Co-operative Production and Sales Societies which number twenty-one in addition assist in marketing the produce of members. Paddy is collected by these Societies and sold to the Director of Food Supplies, or is supplied to rice mills worked by Co-operative Societies or by the Commissioner for Development of Marketing. The Co-operative Production and Sales Societies have been appointed agents by the Commissioner for Development of Marketing for the purchase and supply of produce from the villagers at fixed prices. These Co-operative Societies also assist the villager to market his produce through the Co-operative Central Market in Colombo or through an organization such as the Co-operative Wholesale Establishment.

In addition to these facilities fairs are held three days in a week at Chunnakam, Chavakachcheri, Kodikamam, and once a week at Palai Paranthan and Killinochchi in the Jaffna District, and once a week at Vavuniya. At these fairs the villagers are able to dispose of their produce at competitive prices.

Chewing tobacco meant for the Malayalam market is mainly handled by the Malayalam Tobacco Sales Society. Similar societies for marketing plantains and livestock and livestock produce are in existence and some are in the course of being formed.

Irrigation

The Northern Division, except Jaffna Peninsula and the Islands, is fairly well served by major and minor tanks. The Karachchi Irrigation Scheme in the Jaffna District, Kanagarayankulam, Kanunkerni, Vavuniya, Mamaduwa, Ulukkulama, Eratperiyakulam and Madukande Tanks in the Vavuniya District, and Giants Tank with its chain of minor tanks and the Agathimurippu Scheme irrigate 35,000 acres. The minor tanks scattered through the mainland of Jaffna District, Vavuniya and Mannar Districts irrigate 18,300 acres.

In the Jaffna Peninsula a number of salt water exclusion schemes are under construction to prevent innundations of land with salt water. The Valukki Aru Scheme in the Peninsula assists holding up water in a drainage channel to maintain the moisture of the soil on either side of the Aru. The irrigation of highlands is done from wells and described in full under irrigation of annual crops.

Paddy Cultivation

Almost 40 per cent. of the cultivable area is under paddy. Of a total of 98,881 acres of paddy about 46,000 acres are rainfed and the rest irrigated from a major or minor tank. The rainfed paddy areas are in the Jaffna Peninsula, around Mullaitivu in the Vavuniya District and along the coast in the Mannar District.

Dry Sowing

The cultivation of rainfed paddy differs from that of the irrigated paddy in that the paddy is sown dry and commonly called " Pluthi " as the seed is sown on soil practically dust which is bereft of all moisture. Sowing is done before the rains expecting the seed to germinate with the first N. E. Monsoon showers. The main point underlying this practice is utilization of every drop of rain for the growth and maturity of the crop. Ungerminated seed is also sown on land prepared with the N. E. Monsoon rains. This is done to a great extent under irrigation schemes in the Mannar District as well as under the Karachchi Irrigation Scheme as a means of saving irrigation water, but it is attended by the risk of heavy weed growth if sufficient irrigation water is not available to flood the fields to smother the weeds that may come up with the paddy.

Wet Sowing

Where irrigation facilities are available and where soil conditions do not permit dry sowing, wet sowing is adopted. Wet sowing is invariably done under all minor tanks in the Vavuniya District and on the clay loams under the Giants Tank in the Mannar District. Wet sowing is favoured, for it ensures a thorough preparation of the land and reduction of weeds, as in the course of preparation, i.e., ploughing, bunding in water in the fields after ploughing, and puddling and levelling before sowing the germinated seed, weeds are destroyed and a quick start to the germinated seed is ensured.

Improved Methods

The implements used in paddy cultivation have been improved in recent years. About 26,000 acres are yearly ploughed, harrowed, and the broadcast seed covered by tractor-drawn implements. The use of the Burmese harrow for churning the soil and harrowing the standing crop is steadily on the increase. The use of iron ploughs, both light and heavy, are limited to areas where the soil is sandy, and where there is an availability of draught bulls suitable for use with these ploughs. In general the cultivator is reluctant to change his methods: but in recent years a desire on the part of the cultivator to increase the yield per acre has urged him to try different methods to improve yields as a result of the increased yields obtained in the demonstration plots laid by the Department of Agriculture. Some of the methods which are becoming popular are:

(*a*) Transplanting and manuring paddy by small holders to obtain the maximum yield.

(*b*) Weeding in areas where cheap labour is available.

(*c*) Harrowing the standing crop in areas where irrigation water is ample.

(*d*) Use of pureline seed of varieties generally recognized as suitable for the Province

Planting Seasons

There are three seasons for the cultivation of paddy—the Maha or Kalapogam, Meda or Idaipokam, and Yala or Sirupokam. The Maha cultivation is generally the main major season as it coincides with the major rainfall season, the North-East Monsoon. Generally the extent sown for Maha is very large and sowing dates vary considerably according to the availability of draught animals and labour.

A Meda season in the past was a rare occurrence ; but in recent years due to scarcity of labour and of draught animals, and to the late arrival of the North-East Monsoon rains, Meda cultivation is finding favour as a means of spreading out the cultivation to make the best use of the late rains and full use of the poor supply of draught animals and of labour. The sowing for Meda normally commences in early February and may extend even up to the end of March. Wet sowing is the most common form of sowing seed. The extent sown for Meda is approximately 5,000 acres, and is confined to the Vavuniya District.

The Yala season commences immediately before the Hindu and Sinhalese New Year. It is a means of utilizing irrigation water left over after cultivation for Maha in major and minor tanks. The extent cultivated for Yala in the Vavuniya District is invariably low due to the cultivation of paddy for Meda ; whereas under the Karachchi Irrigation Scheme in the Jaffna District, Kanukerni Tank in the Vavuniya District, and Giants Tank in the Mannar District where there is no Meda cultivation, the extents cultivated for Yala in normal years are fairly large and it may be as much as 50 per cent. of the total area under the tank. For Yala 1952 the proportions cultivated are 6,600 acres under the Karachchi Irrigation Scheme, 320 acres under Kanukerni and 2,420 acres under the Giants Tank. Tank beds under low sluices are usually cultivated for Yala under the Giants Tank.

Subsidiary Crops

In the Jaffna Peninsula where there are no tanks and where paddy is cultivated with the rains, certain tracts such as Pandatherappu, Changanai, Mathanai, Mathagal, Manipay, Vadaliaddaipu, Karainagar are cultivated with crops such as tobacco, chilli, onions, manioc, brinjals and vegetables with well irrigation. When well irrigation is not possible as in Vaddukoddai, Araly, Karainagar, Kalapoomi, Moolai, Tholpuram, Navaly, Kaddudai, Sandilipay, sunhemp is sown immediately after the harvest of paddy, with the moisture still in the soil, as a means of fertilizing the soil. This crop in addition yields fodder for cattle and a small income if the stalks are sold. On fairly high land a mixture of 3 measures of gingelly and 5 measures of green gram is sown. If there should be a few showers in March and April, the sunhemp, gingelly and green gram yields well. Nett incomes of Rs. 100 and over are not rare.

Subsidiary crops grown on an intensive scale on paddy land with well irrigation are as remunerative as those crops cultivated on highland. In addition, the paddy which follows these crops gives very high yields, in some cases as much as 48 to 50 bushels per acre. Paddy seedlings are raised with well irrigation for transplanting. This is necessary as the subsidiary crops occupy the land till the middle of October.

The cultivation of subsidiary crops on paddy land is not practised in any other part of the Northern Province.

Highland Cultivation

Under this heading the cultivation of crops other than paddy is dealt with, both perennial and annual.

Perennial Crops

Coconuts, arecanuts and fruit trees inclusive of mango, citrus, jak, pomegranate, &c., are cultivated. The palmyrah which is found in abundance in the north and east of the province, is not cultivated systematically and is mainly the outcome of fallen fruits allowed to grow unattended.

Coconuts cultivated along the east coast in Pooneryn in the mainland, along the coast of the Jaffna Peninsula and in gardens totals 24,232 acres. The land in which coconuts are cultivated is a very sandy loam ; and the success of this crop depends on the steps taken to conserve moisture and on the amount of organic manures added. Cattle, goats and sheep penning in addition to growing of *Tephrosia purpurea* as green manure are the main ways of adding organic material.

Fruit trees except in very exceptional cases are not cultivated on an orchard scale. In the case of the mango a few trees of each variety are planted in gardens. Very few gardens in the Jaffna Peninsula are without a few mango trees. In the Vavuniya and Mannar Districts it is the reverse, only a few gardens have mango trees. In the Jaffna Peninsula 90 per cent. of the trees are budded or grafted. The varieties on a rough estimate number over two hundred. The most common varieties are Vellai Columban, Karutha Columban, Ambalavi and Chembattan. Little or no systematic cultivation is done except in the early stages when the plant is nursed to maturity by manuring and irrigation. In normal seasons the price of a mango fruit varies between 10 and 20 cents.

Citrus on the other hand is more popular in the Vavuniya District than in the Jaffna or Mannar Districts. Vavuniya sweet orange takes pride of place amongst the varieties cultivated in Ceylon. They are large, loose skinned and medium sweet. A few trees in each compound are more general than large orchards. There are only six orchards of an acre or more. The short life of orange trees, especially of budded trees, has to a great extent discouraged large orchards. Seedling plants tend to live longer than budded plants. Unlike the mango, citrus plants are systematically manured and irrigated. Heavy dressings of organic material and regular irrigation tend to extend the life of a plant. One or two orange plants per compound, and that too far and apart, are found in the Jaffna Peninsula. The other citrus variety which is commonly cultivated throughout the Province is the lime plant which is found cultivated under irrigation in all gardens. The most popular variety is one akin to the British Guiana lime. Lime trees are forced to bear right throughout the year by heavy dressings of organic material and regular irrigation.

Miscellaneous fruit trees such as pomegranate, grape vine, sapodilla, breadfruit, &c., are cultivated in scattered gardens in the Jaffna Peninsula. Pomegranate yields fair harvests in Point Pedro and Kayts in the Jaffna District, and in the Mannar Islands in the Mannar District where the sandy soil and dry climate are suitable for this crop. Grape vine was at one time a very good source of income to the cultivators in Mathagal, Sillalai and Vasavilan

in the Jaffna Peninsula; but in recent years the cultivation of this crop is on the decline mainly due to the incidence of pests and diseases which the cultivators find difficult to control.

Annual Crops

There are two main forms of cultivation—one extensive under rainfed conditions, and the intensive method with irrigation from wells. The extensive form is mainly confined to gardens and chenas in the Vavuniya District and provides part occupation to those who are really paddy cultivators. The gardens are blocks of land adjoining dwellings. These are prepared for planting crops such as chilli, manioc, maize, cowpea, sorghum and vegetables with the first showers of the North-East Monsoon. In normal years of rainfall very remunerative incomes are obtained by the sale of green chilli and vegetables which come into production in December when there is a demand.

Chena cultivation in recent years is confined to blocks of Crown jungle given out to middle-class persons and peasants in the Vavuniya, and to a very few in the Mannar and Jaffna Districts. Paddy chenas are more popular than a mixture of kurakkan, cowpea, mustard, chilli, maize, &c. This change over is partly due to the change in the issue of land permits which are confined to land which can be asweddumized as paddy land. Middle-class allottees seem to prefer paddy. These allotments will, in time, have permanent crops such as citrus, and annual crops such as chilli and onions under well irrigation. All land both highland and chenas cultivated extensively are with few exceptions sown in March and April with gingelly and green gram immediately after the harvest of the Maha crops.

The general trend in recent years is towards the intensive form of cultivation. This is due to the fairly high minimum prices guaranteed, and because of the increase in marketing facilities provided for products such as chilli and onions and the high prices realized for local and Malayalam tobacco, plantain, betel, and local vegetables.

In the past intensive cultivation of crops such as chilli, tobacco, plantains and onions were confined mainly to the Jaffna Peninsula; but during the past ten years the intensive form of cultivation has increased considerably in the Vavuniya District.

The intensive form of cultivation depends on the availability of water for irrigation from wells. Sinking of wells with good supplies of water is a certainty in the Jaffna Peninsula. Water levels in the Jaffna Peninsula are more or less maintained right throughout the year because of the regular flow into the well of water held in the numerous cavities of the sub-soil rock formation.

Wells with good supplies up to the end of July have been sunk in a few centres in the Vavuniya District. A few such centres are Rambaikulam, Vairavapuliankulam, Sinnakulam, Puthukulam, Thatchankulam, and Kulamkulam in Vavuniya South Tamil Divisional Revenue Officer's Division; Odduchuddan, Nedunkerni, Thanduwan, Palampasi, Mamadu in the Vavuniya North Divisional Revenue Officer's Division; and Muliavalai Taniyuthu, Kumulamunai and Kanukerni in the Maritime Divisional Revenue Officer's

Division. With the restoration of tanks in the District more centres with good supplies are now found. Wells in the Vavuniya District depend on seepage water from the neighbouring tanks.

A well in the Jaffna Peninsula will irrigate about 2½ acres whereas a well in the Vavuniya District can irrigate only one acre because of the poor flow.

Water is lifted from the well by means of well sweeps, single mhotes, double mhotes and pumps. The layout of the land for irrigation varies with the crop cultivated, and a full chapter could be written on the subject if it is to be dealt with in detail. The layout presents no difficulty as the land is level. Leading of the water into bays planted with the crop is the commonest method of distribution of water. The channels, bays, &c., are so designed that it is not only economical in labour but also saves water and time in irrigation.

A rough estimate of the acreage and crops cultivated are as follows:—

Crop	*Rainfed*	*Irrigated*
Chilli	480 ..	2,720
Tobacco	— ..	3,000
Onions	— ..	5,000
Manioc	900 ..	500
Maize	505 ..	—
Sorghum	350 ..	—
Gingelly	3,000 ..	—
Green gram and other pulses ..	550 ..	400
Local vegetables ..	350 ..	1,550
Yams	— ..	250

Definite forms of rotation are practised. The land is manured so heavily that as many as three crops are taken in one year from the same land. The most common rotation was tobacco and a cereal followed by a short-term legume such as green gram, all cultivated in the course of the same year. In recent years due to the fall in prices of cereals, onion which has a very remunerative minimum guaranteed price is cultivated instead. There are rotations with chilli as the major crop followed by a cereal. A five-year course rotation is practised in areas where plantains are cultivated. If yams which occupy the land for nine months is the main crop, yam is planted with mixed local vegetables such as brinjals, pea, &c. Manioc is often found in a rotation and mainly on land which requires cleaning. Manioc is planted on this as a single crop, or mixed with a cereal or onion.

Rotations vary according to place and convenience of cultivators; but in all cases the principles underlying rotation are not lost sight of.

The actual commencement of cultivation of annual crops is the tail-end of the N. E. Monsoon season, that is December. The three main planting seasons are the December, April and July planting seasons.

The heavy manuring consists primarily of dressings of earth manure and green leaf ; cattle and sheep manure is also very common. Growing of sunhemp as a green manure is very widely done. Hedges planted with Gliricidia, dadap, tulip, &c., provide a fair portion of the green leaf required.

Livestock

The livestock population as enumerated in the Census of 1946 is as follows:—

	Cattle	*Buffaloes*	*Goats*	*Pigs*	*Fowls*	*Sheep*
Jaffna District ..	94,128	1,098	70,784	119	111,215	7,000 (Estimated)
Vavuniya District ..	13,848	7,829	1,184	30	9,615	—
Mannar District ..	12,758	7,415	6,791	23	11,772	—

There is very little difference in the number of cattle and goats, but the number of poultry has increased considerably since the Census.

The type of livestock in the Province is in keeping with what may be called an equilibrium with the food supply, and any change cannot be seen in the type without seeing some change in the means of feeding and management. For example, in the Jaffna Peninsula where the standard of feeding and management are far superior to that in the rest of the Province, the livestock maintained are definitely of a better type.

Except for pure-bred draught cattle and a few cows imported from India, the rest of the cattle in the Peninsula are crossbreds. Both European and Indian breeds have been utilized in the evolution of these types. The cattle in the rest of the Province consist mainly of the Singhalese type bred indiscriminately.

The goats in the Jaffna Peninsula are crosses of the Jamnapari, Kamouri, Alandi and Surat breeds with the local indigenous breed. The goats in the Mannar and Vavuniya Districts are of the meat type and are akin to the South Indian goats. The original stock seems to have been imported from South India and fresh blood introduced from time to time.

The poultry in the Province are as a rule of very mixed breeds. The R. I. R., Australorp and White Leghorns breeds have been utilized from time to time to improve the stock. Poultry-keeping could, having careful regard to the limitations of feeding and breeding, be very considerably improved.

Sheep are generally utilized for manuring, and thrive on the sparse grazing available in the Jaffna Peninsula.

Buffaloes provide the main draught in the cultivation of paddy. These maintain themselves on the grazing available in the jungle and tank beds. Very little progress has been made with the breeding and feeding of buffaloes.

Photo 1.—Bullock operated water lift on well.

Photo 2.—Flume from well.

Photo 3.—Lined pond for irrigation.

Photo 4.—Irrigation from ponds with palmyrah pails.

Photo 5.—A garden of irrigated chilli.

Photo 6.—Penning cattle in Jaffna.

Observations on Drainage Conditions of Ceylon Paddy Soils with Particular Reference to those of the Low Country Wet Zone

J. G. VERMAAT

Introduction

SOIL productivity is the crop-producing potentiality of a soil. It is to be measured in terms of yield. The productivity as such is conditioned by physical factors, e.g., climate, depth of topsoil, nature of subsoil, drainage conditions, etc. The yield level is generally conditioned by these physical factors. These are fixed to a certain extent, and one can do relatively little about them, with the exception of drainage. They are controlled by nature (10).

Soil fertility is the capability of a soil to supply at any time nutrients to a crop in adequate amounts and suitable proportions. Fertility can easily be controlled by men (10).

Differences of several hundred per cent. are possible, even in adjacent fields as a result of differences in physical characteristics. A difference of 100 per cent. or so is seldom to be obtained by the application of fertilizers.

Hence comparative studies of yields are of great importance in tracing limiting factors in crop production. Dr. M. F. Chandraratne's preliminary yield survey, the first of its kind in Ceylon, showed already highly interesting and instructive figures. An illustration of this will be found in the data of Mr. R. S. Koshal's yield surveys during Maha 1951-52 and Yala 1952 covering the whole island. The following figures were obtained from the survey in Maha 1951-52.

Locality	*Province*	*Paddy in lb./acre*	*Clean Rice in lb./acre*
Ceylon ..	..	1,424 ± 19·5 ..	949·3 ± 13
Ratnapura District ..	Sabaragamuwa ..	1,018 ± 72·7 ..	678·6 ± 48·5
Galle District ..	Southern ..	770 ± 37·0 ..	513·3 ± 24·5
Kalutara District ..	Western ..	806 ± 61·8 ..	537·3 ± 41·2
Kandy District ..	Central ..	1,964 ± 116·1 ..	1,296·2 ± 77·4
Nuwara Eliya District ..	Central ..	2,192 ± 172 — ..	1,461·3 ± 114·6

The differences in yield of the various districts in the wet zone is such as to suggest the existence of limiting factors of a physical nature in the areas with a low yield. Therefore a preliminary survey of paddysoils was started in order to trace limiting factors in rice production in the S.W. It soon turned out that in all probability inadequate drainage was one of the limiting factors. In this paper conditions of drainage of paddy soils in the S.W. will be dealt with.

The Importance of Drainage for Paddy Soils

Rice is, to a certain extent, a water plant, but certainly not a marsh plant. Its roots are equipped with large cavities, which run from the rootcrown down to the very roottip, and are filled with O_2 and CO_2 and might be some other gases such as N. A gradient exists from the base of the roots to the tip. So it was found by van Raalte, who carried out these fundamental researches, that at the base of a 20 cm. (8″) long root the gasmixture in these cavities contained 9-14 per cent. O_2 and 2.8-6.1 per cent. CO_2 in different varieties. The corresponding figures for the roottip are 1.9-4.7 per cent. CO_2 and 2.1-8.1 per cent. O_2 (6). He further established the fact that the O_2 is taken up by the aerial parts and the rootcrown either in the gaseous or in dissolved form and is conducted to the lower parts of the roots through the aircavities in the cortex.

In a subsequent investigation van Raalte demonstrated that the roots also exude oxygen into the surrounding medium. In this way the paddy plant is in a position to create its own atmosphere around its roots and to thrive in a thoroughly reduced medium. Nutrient uptake in the rhizosphere can therefore proceed in the same way as in normal landplants (7).

As a result of the inundation the soilorganic matter, applied bulky organic manures, start to decompose under anaerobic conditions. It is due to a series of now classical experiments by Harrison and Subramaniam Ayer that we understand various aspects of the mechanisms involved. They found that in a cropped paddysoil CH_4 H_2, N, and CO_2 are formed. Bacteria reduce the CO_2 with the help of the H_2 to CH_4. So CH_4 and N gas accumulate and move upwards. The roots however form near the soilsurface, thus in contact with oxygen carrying water a network of fine roots. Between and over them a film of microorganisms (bacteria and algae) has formed. The bacteria oxydize the methane to CO_2 and H_2O and the algae during day time assimilate CO_2 and give O_2 off. So under the film and near contact with the roots O_2 accumulates in a gaseous form and dissolve in the water according to its pressure.

If drainage were quick much of the oxygen produced would go down in the soil and be utilized by the reduced substances there, and it might be doubted whether the roots could satisfy their requirements. By a moderate and slow drainage however the roots have ample opportunity to take all the oxygen they need and the balance either escapes through the supernatant water or drains off into the subsoil and is used for oxidation of reduced substances (3). Application of bulky organic matter on an adequately drained soil has the effect of increasing the oxygen supply to the roots (4, 5.)

Under flooded conditions the soil beyond the rhizosphere is fairly reduced and especially so when bulky organics such as green manure, cowdung or compost are amply applied. Not only toxic organic substances may be formed, but also nitrites and further ferrous iron and sulfides, all of which are highly toxic. Slow drainage partially takes care of their disposal. Ferrous iron and sulfide ions form the highly insoluble FeS. An excess of $Fe^{\cdot\cdot}$ which reaches the rhizosphere becomes oxidized and is precipitated in the ferric form. Hence a brownish red coating around many of the older roots may arise.

The amount of oxygen exuded by the root system of a two months' old paddy plant is 1-3 mg./day, sufficient to oxidize 7-21 mg. of $Fe^{\cdot\cdot}$ (7). In a soil which is freshly heavily green manured or to which large amounts of bulky organic matter have been applied the amount of oxygen exuded might not be sufficient to cause the ferrous iron to be precipitated

as ferric iron (7). Here we have the explanation for the observed fact that poorly drained soil should not be heavily green manured or receive large doses of compost or farmyard manure (Fe . . poisoning!).

These considerations are corroborated by investigations from Japan and Indonesia (9 : 2-3 ; 1 : 53-54 and 2 : 26-28), both countries in which much attention is paid to appropriate and adequate drainage.

For successful paddy growing water supply, water consumption and water losses have to be well balanced and in order to achieve this water control is required. But water control means the availability of adequate irrigation and drainage facilities, which allow control of irrigation and drainage and which is not or inadequately the case with the native irrigation and drainage systems (at least in the S. W.).

With irrigation facilities is meant a system of supply channels and or ditches equipped with gates (or sluices) and measuring weirs so that the amount of water supplied from a catchment or tank to tracts of paddy fields can be measured and controlled.

With drainage facilities is meant a system of ditches and channels equipped with gates (or sluices) and where necessary provided with pumps to dispose of any water in excess of the actual requirements of the tract under consideration. Especially during floods adequate drainage facilities prove their value.

The Water Regime of Paddy Soils in General and those of the South West in Particular

Water supply is the sum of the amount of rainfall and irrigation water supplied to the soil.

Water consumption is the amount of water used by a plant in building up its body and used in transpiration.

Water losses comprises the amount of water lost by evaporation from the water surface and losses due to leakage in the subsoil, thus natural drainage.

The actual requirement results from these various components.

Just as we supplement the natural supply of rainfall by irrigation, either controlled (technical) or native, in the same way we assist the natural drainage by additional surface or controlled drainage.

The extent to which water losses occur depends upon:

(*a*) evaporation from the free surface,
(*b*) the prevailing subsoil drainage.

Subsoil drainage again is controlled by:

(*a*) the permeability of the soil profile as a whole, and
(*b*) the topographical position of the fields under consideration.

The guiding principle in measuring the amount of irrigation water supplied is of course that of the utmost economy in the use of water resources.

In the second paragraph we saw that drainage is necessary. We can however distinguish between subsoil and surface drainage. When we could reduce subsoil drainage to zero, it would be possible to approach the strictest economy in water use as surface drainage can be controlled easily. Apart from the point whether it is desirable to eliminate subsoil drainage completely, it is not well feasible either.

In various countries such as Indonesia a semi-impervious layer is created deliberately during the preparation of the paddy field, in order to reduce water losses through seepage to the minimum. In many Ceylon soils which as a rule contain a far lower clay content this is not well feasible.

Java:			*Ceylon*:	
0·5 micron	± 50%			
0·5—2·— „	± 15%			
Total clay	: ± 65%		Total clay (2 micron)	± 30%
2—20 micron	: ± 10%		Silt (2—20 micron)	± 10%
Silt + clay	: ± 75%		Silt + clay	± 40%

From these figures we can understand why it is so much more easier in Indonesia than in Ceylon to form a semi-impervious layer in the soil ; especially so since the amount of mobile iron and manganese in Ceylon soils is probably considerably lower than in Java soils. And it is these two elements particularly the iron, which contribute to the panformation as they act as a coating material for the finer particles.

Whereas in Indonesia subsoil drainage is reduced and surface drainage takes its place, many Ceylonese paddy soils have an excellent subsoil drainage. Water losses due to subsoil drainage may be considerable. Due to this and the fact that paddy cultivation in Ceylon was first introduced in the dry zone (less than 75″ rainfall a year) by means of highly ingenious and elaborate irrigation systems, surface drainage did not need and consequently did not receive the attention it required in Indonesia.

After the decay of the Anuradhapura and the establishment of the Polonnaruwa Kingdom a further shift to the S. W. of Ceylon occurred. So it is recorded that during the period when Parakrama Bahu was Governor in the South swamps and marshes were reclaimed and transformed into paddy fields in Pasdun Korale (Kalutara District)*.

In this region, however, the rainfall in many cases exceeds 100″ a year. A few cases may illustrate this:

Locality	*Altitude*	*Rainfall*	*Period of observation*
Labuduwa ..	30′ ..	112·69″ ..	21 years
Agalawatte ..	220′ ..	167·62″ ..	14 „
Kalutara ..	10′ ..	112·52″ ..	79 „

When the rainfall was distributed equally over the year this would not matter very much and subsoil drainage probably could cope with it. However most of the rains come down in showers of high intensity (several inches per hour) as has been observed repeatedly at the

* S. F. de Silva: A *Regional Geography of Ceylon*, 1952.

last two stations mentioned above. And these are the rains with which even the best subsoil drainage cannot cope. In order to prevent calamities of a nature as will be dealt with further on in this paper surface drainage is needed to supplement existing subsoil drainage. This holds especially true where impervious layers occur in the subsoil. So the following profile occurs at the experimental farm Fullerton near Nagoda (Kalutara District):

0 — 8″ peaty topsoil
8″ — 12″ coarse gravelly sand
12″ — 20″ peaty fine sand
20″ — 28″ sand
28″ — 44″ grey sandy clay
44″ — 56″ very stiff bluish-grey clay, impervious
56″ — — coarse sand

Due to the impervious layer at 44″ the peaty layer between 12″ and 20″ came into existence. Later during a serious flood this original peaty layer was covered by coarse gravelly sand, but still the impervious layer at 44″ had its influence and a new peaty layer was formed on top of the sand. At the Labuduwa Experimental Farm a similar impervious layer was found at a depth of only 10″, also resulting in peaty development of the overlying layer. Mr. S. Kandiah observed in river valleys in the Kotmale area that inadequate subsoil drainage resulted in an appreciable decrease in yield compared to adjacent fields with adequate subsoil drainage.

In the Ratnapura District as for instance in the Karapincha region the topography prevents the free drainage of the water accumulating in the subsoil. Here one finds so-called intermontane basins, in which water accumulates.

In all those cases where due to one factor or other free subsoil drainage is restricted *surface drainage* has to give a hand and supplement the subsoil drainage.

Sometimes it is possible to improve upon subsoil drainage in a rather simple way as in those cases where a thin impervious layer occurs near the surface. By digging out or breaking through this layer (often consisting of kaolin) a considerable improvement can be achieved. Cultivators at Makumbara (near culvert 13/7 along the Colombo-Ratnapura road) did this quite successfully.

In cases of topographical obstructions surface drainage, eventually assisted by pumping is the only solution. In this case natural or subsoil drainage is practically zero. But this condition, though it eliminates all uncontrollable water losses by seepage is far from ideal. For successful paddy cultivation we need moderate, slow drainage *through* the soil, supplemented by surface drainage. *The advantage* of surface drainage is that it offers us the possibility of using the excess water drained off over and over again. In using so the amount originally supplied by either nature or men to the highest degree of efficiency, we do exactly what Parakrama Bahu the Great had in mind and left as *the commandment* for the people of Ceylon, when he said: " Let not a drop of water fallen in my Kingdom reach

the sea, without having rendered the highest benefit to my lands and crops." Alas it has to be observed *that the cultivators of Ceylon do not appear to have acted accordingly*, for nowhere in rice growing countries is so much water wasted as in Ceylon.

A six-month paddy crop does not need more than 6½ feet of water, rain and irrigation together, but there are enough places where the farmer uses double this amount of irrigation water alone and nearly treble when one takes the rainfall into account. This waste of valuable water both through seepage and over-irrigation leads up to another aspect of economic use of available water, namely the supply of water.

Due to the rugged topography of the mountain ranges in S. W. Ceylon, the slopes are rather short and steep. And although this type of country is already difficult to handle under natural conditions, deforestations has made things worse. Many catchment areas are badly eroded and ..... erode still, the colour of Ceylon rivers proves this point. It is an exception when a catchment area functions properly, catches the water *and* stores it, only in order to release it gradually. The present situation is that not only showers of high intensity, but all rains rush down the slope of a catchment, carrying with it whatsoever is left of topsoil and accumulated organic matter towards the nearest river.

As a result of the geomorphological development of the S. W. of Ceylon the valleys have gradually silted up and the volume of water they can transport is relatively small. And so many streams and rivers in the S. W., such as the Kelani and Kalu Ganga flood regularly. Areas subjected to flooding are apt to become waterlogged. The only remedy is to devise drainage systems, which take care of the water and make it available where it is needed.

The attention might be drawn to the fact that similar conditions caused the floods in the Tennesse river basin (U.S.A.), till the people decided to do something about it and created the Tennesse Valley Authority (T. V. A.).

Much of the excess water in S. W. Ceylon could be used to the advantage of the dry zone in E. and S. E.—Ceylon. But this requires the projection and building of big channels. From the engineering point of view such a project is entirely feasible.

However such a channel does not exist at present and therefore we cannot go farther than an adequate catchment protection at present. Thus proper soil conservation measures together with adequate drainage facilities, in order to protect the paddy fields at the bottom of the catchment against water calamities. It would exceed the scope of this paper to deal with this matter in more detail.

Erosion of Paddy Fields, particularly of those in S. W. Ceylon

The absence of proper conservation measures and drainage facilities in many catchment areas and paddy tracts in S. W. Ceylon are co-responsible for the sad fact that Ceylon is one of the very few if not the only rice growing country in the world where asweddumized paddy fields are subject to serious erosion.

Erosion of an asweddumized paddy field is loss of clay and silt, both so to say fertility carriers, and are substituted by sand and gravel, resulting in a decrease in both productivity and fertility.

Every shower coming down the catchment slope carries with it much fine gravel, coarse and fine sand and also some clay and silt and last but not least organic matter. The openings in the bunds are not designed to cope with these large amounts of water, nor is the storage capacity of the *liyaddes*, which according to Mr. R. S. Koshals' sample area survey are about a tenth of an acre in Kalutara and a sixth of an acre in Galle District, sufficient for all this water, with the result that it soon rises to the top of the bund and starts to overflow. More than one bund collapses and finally a fast moving stream, which stirs up the topsoil and carries the clay and silt with it, moves over the fields towards the nearest drain and is lost. The paddy field becomes only richer in sand, which in Ceylon is equivalent to sterile quartz sand. In the lower lying *liyadde* one finds in front of the opening in the bund of the adjacent higher lying *liyadde* a large fan of fine and coarse to gravelly sand.

The cultivator is aware of the fact that floods do more harm than good to his fields and therefore endeavours to dispose of the water as quick as possible by laying out drainage channels over the paddy fields, which converge to the opening in the bund, draining in the lower *liyadde*. It might be even possible that this is the cause of the waste of irrigation water, which prevails. In no other place the writer saw water flowing so fast over paddy fields as in Ceylon.

But the cultivators' own practices result many times in loss of clay and silt, thus result in erosion. During the preparation of a paddy field the soil is trampled when the field is flooded in order to bring it in a so-called mudded condition. As long as the cultivator gives this suspension of clay, organic matter and a little silt time to settle down ($\pm$ 4 days — a week) before draining off the water and preparing the field for sowing, no nutrient carriers are lost. Many times however the rains come rather late, and the cultivator starts too late with his operations and cannot afford to wait long enough to let the mud settle down. If however he drains off the field too early much valuable material is carried down to lower fields till finally it reaches the drain and is lost. Unfortunately this is more often the case than not. Probably the only feasible answer will be to make the paddy fields independent by irrigation, such as for instance lift-irrigation.

Summary and conclusions

1. Well drained irrigated paddy soils give higher yields than poorly drained ones. For optimal production paddy requires a good balance between water supply on the one hand and water consumption and water losses due to evaporation, subsoil and surface drainage on the other.

2. The clay content of the paddy soils of Ceylon throughout the wet zone is rather low, as a rule, as compared with the volcanic soils of Indonesia.

3. As a consequence of this difference in clay content no semi-impervious layer is formed by mudding the soil of paddy fields in Ceylon, and this results in considerable losses due to seepage. This is one of the reasons why the actual amount of water used in Ceylon to raise a paddy crop is so much higher than the water requirements of paddy in other tropical rice growing countries.

4. Conservation, and where possible an increase in the clay content of wet zone paddy soils, are synonymous with conservation of or increase in soil productivity and fertility respectively.

5. In order to prevent any further decrease in clay and silt content of paddy soils caused by the increased run-off after heavy rains, the introduction of suitable and adequate conservation practices in the catchments is urgent.

6. Surface drainage should receive more attention not only in those areas mentioned, but especially in those areas where due to topographical factors or profile characteristics, subsoil drainage is restricted.

7. The measures indicated under (5) and (6) can be linked up with irrigation systems and so more rainfed paddy land will become irrigable and give higher yields.

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Oxidation-Reduction Potentials in Rice Soils – Trends in a Dry Zone Field

C. R. PANABOKKE

Introduction

THE earliest work on the study of oxidation-reduction potentials developed in soils was that of Gillespie (1) in 1920. Aspects of this subject have been taken up at various times by different workers, and in some instances their findings have had practical application. The better known investigations are those of Bradfield, Batjer, and Oskamp (2) and of Peech and Batjer (3) on the relation of the oxidation-reduction potentials to fertility in orchard soils, and the work of Pearsall and Mortimer (4) whose findings have been successfully exploited by the Japanese in the manuring of rice by the deep placement of ammonium sulphate. A recent publication on oxidation-reduction potentials carried out in rice soils is that of De Gee (5), where reading were taken *in situ* in a field with rice plants two months old, in order to test the theory regarding the formation of a " sawah " profile (Koenigs, 6).

In the studies carried out in 1952-53, in a rice field at the Agricultural Research Station, Maha Illuppalama, oxidation-reduction potential measurements were made at points down the depth of the profile, at various intervals, starting from the time just prior to transplanting (i.e., a fortnight after flooding). These studies show the trends in depth zonation of the oxidized and reduced layer with time, and suggest certain modifications in the present practice of the application of top dressings of ammonium sulphate.

Theoretical Considerations

A definite potential difference exists between an unattackable platinum wire and a solution containing a mixture of oxidant and reductant which can be brought into a reversible equilibrium. The theoretical expression that equilibrates an oxidation-reduction potential and the system it represents is given by the relation : $E_h = E_o - \frac{RT}{nF} \text{ in } \frac{(\text{oxid})}{(\text{reduc})}$ where E_h = potential in volts referred to the normal hydrogen electrode as zero of the system under consideration,

E_o = constant characteristic of the system,

R = Gas constant,

T = Absolute temperature,

F = Faraday = 96500 coulomns,

n = number of electrons involved in change from oxidized to reduced form,

(oxid) = concentration of oxidized form,

(reduc) = concentration of reduced form.

The electrometric method of measuring this potential consists in building an electric cell in which the system under study is made one half cell, and the other half is any standard cell. The unknown half cell has an unattackable platinum electrode immersed in the system under study. The two half cells are connected by an electrolytic bridge and the electric potential is measured by a potentiometric set up.

The accurate determination of the potential of a soil system is a difficult procedure because the soil is very heterogeneous and contains several distinct oxidation-reduction systems, some of which poise only with difficulty in the presence of biological catalysts. On account of the presence of iron in all soils, one could interpret all potentials of the soil system in terms of the system $Fe^{+++} + e \rightleftharpoons Fe^{++}$ But one cannot avoid the possibility of other systems participating, some of which exist in the colloidal condition and contain many kinds of organic matter oxidizable to different extents. However, in a well-aerated soil where the $Fe^{+++} + e \rightleftharpoons Fe^{++}$ system predominates, the theoretical formulations will hold quite well. Yet the measurement of oxidation-reduction potentials in a paddy soil by a method where the system can be well poised would be very useful.

Experimental Procedure

Gillespie (1) measured the oxidation-reduction potentials of water-logged soils by allowing the platinum electrodes to remain in the soil covered with water and measuring the potential each day. Brown (7) allowed the platinum electrode to remain in contact with a soil-water mixture of fixed ratio, and employed centrifuging of the system to bring about better contact, after which the potential was measured. Both these methods were tried out, but proved unsatisfactory as potential drifts were observed in all cases which had no regularity in behaviour to permit a system of standardization. The measurement of the potential of a water-logged soil when suspended in 0. 1 N sulphuric acid proved to be the most satisfactory as the systems were well poised at this pH, and hardly any potential drifts were observed after standing for 30 minutes. As all results were to be transformed to the E_h at (pH = 7) scale, the pH – E_h relationship was determined by measuring the Eh at various pH values of the soil in 0. 1 N sulphuric acid. A pH – E_h slope of 0.07 volts per unit change in pH was obtained, which held constant for the soil at all respective depths down the profile.

The platinum electrodes which were cleaned with hot chromic acid, rinsed in distilled water and heated over an alcohol flame, were placed in the 0. 1 N sulphuric acid soil suspension, and the tube containing the soil was well tapped to ensure good contact between the soil and the platinum electrode. After standing for 30 minutes contact was made with a standard (silver/silver chloride) electrode through an agar bridge and a potentiometric set up, which measured the electric potential of the cell. A pH determination was also made of every sample after the E_h determination, and the E_h was corrected to E_h at pH = 7. The soil samples were collected in the field from the respective depths down the profile into small, darkened, air-tight bottles with minimum delay. The manner of drawing the sample was to scoop out a soil monolith lying between two points

(say 5—7 cms. from the surface) with the aid of a spatula from a freshly cut face of the profile, and the E_h value of the sample from this zone is designated to that at a point 6 cms. from the surface. The surface samples were taken by gentle superficial scooping of the surface.

From a field which was transplanted on November 24, samples were taken on November 23 (i.e., a day prior to transplanting) and again on December 8, to a depth of 100 cms. down the profile. Thereafter samples were taken to a depth of only 15 cms. on the following dates:—December 27, January 3, January 11, January 20 and January 27. A shortage of irrigation water due to failure of rains curtailed progress beyond this stage.

Results and Discussion

Readings taken on November 23 and December 8, 1952, which are represented in curves A and B of Fig. 1, show the trend in the building up of the oxidation-reduction potential profile at the early stages. An increase in value of the surface layer from a potential of −10 millivolts to +50 millivolts, together with an overall increase in the oxidation-reduction potential over the whole length of the furrow slice, has occurred within the period of the first two weeks. The shape of the curve also indicates that oxidative conditions prevail below the furrow slice. Such oxidative conditions could be associated with good sub-soil drainage.

In curve C (Fig. 2) which represents the reading on December 20, it is observed that the potential of the surface has increased to a value of +290 millivolts. The above trend in the development of the oxidation-reduction potential curve could, to a certain extent, be explained on the existing knowledge of the behaviour of paddy soils. When a paddy field is flooded with irrigation water, the microbiological balance in the soil is considerably altered. Under the resulting anaerobic conditions, the heterotrophic organisms which decompose organic matter and consume oxygen, give rise to reduced conditions in the puddled section of the furrow slice. In course of time, however, the water which is charged with oxygen both from the atmosphere and from the hydrophytic plant associations, influences the uppermost layer of the paddy soil, and conditions favourable for the growth of the autotrophic organisms in this layer result. The enhancement of the autotrophic activity with time is reflected in the rate of building up of the oxidation potential of this layer.

It is known that when ammonium sulphate is applied to the surface of the paddy field the ammonium nitrogen is oxidized to the nitrate nitrogen by the aerobic organisms. This nitrate nitrogen on leaching downwards undergoes de-nitrification by the anaerobic organisms and ultimately escapes as free nitrogen. From the trend in the oxidation potential values so far observed, it appears that the oxidation of ammonium nitrogen at the surface which will be slow in the initial stages, would be greatly intensified with time. A cultural practice which could incorporate the ammonium sulphate in the reduced section of the furrow slice, at the time of application of top dressing, is accordingly desired.

The determinations made on December 27, 1952, January 3, 11, 20 and 27, 1953, cover the period between the phase of tillering and the phase of initiation of inflorescence primordia, and are represented in curves D and E (Fig. 2), F, G and H (Fig. 3). The sequence indicates a breaking up of the furrow slice into several zones where alternate oxidative and reductive conditions prevail.

Evidence supporting the view of a downward diffusion of oxygen (8) may be found in the overall rise in the oxidation potential of the reduced layer. In the early stages, under the prevailing conditions of equilibrium, the furrow slice is composed of a thin superficial oxidized layer and a broad reduced layer beneath it. This situation gradually undergoes transformation on account of certain other operative factors asserting their influence. The diffusion of oxidative substances from the roots of the rice plant (9) will influence the equilibrium in the reduced section of the furrow slice. Moreover, a peculiar development of the profile in the flooded furrow slice of a paddy soil (8), explainable on the principle governing the Liesegang phenomenon, where a downward diffusion of oxygen followed by certain physico-chemical changes ultimately results in the formation of thin bands of ferric hydroxide down the profile, is corroborated by the evidence borne out in the shape of the curves: D, E, F, G and H.

Conclusions

In the development of the oxidation-reduction potential profile, certain factors manifest themselves. Microbiological activity is followed up by the diffusion of oxygen from the surface of the soil and from the roots of the rice plant. These processes running parallel to each other and acting in unison, give rise to a system of equilibrium initially simple and finally complex.

An increase in the value of the oxidation potential of the surface layer with time is observed. The importance of incorporating the ammonium sulphate in the reduced zone of the furrow slice at the time of the top dressing is indicated.

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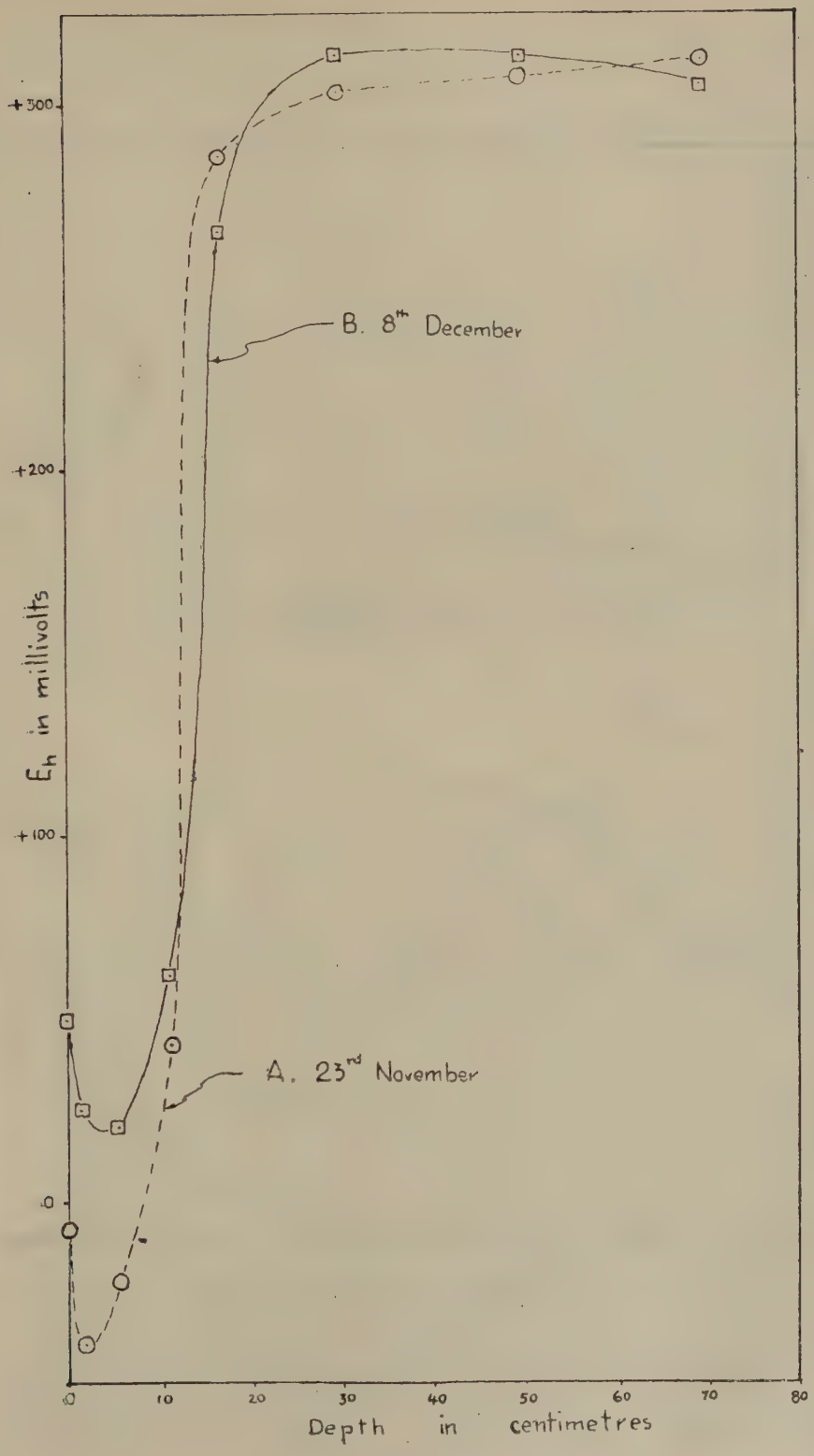
+300
+200
+100
0
E_h in millivolts
B. 8th December
A. 23rd November
0
10
20
30
40
50
60
70
80
Depth in centimetres

Fig. 1

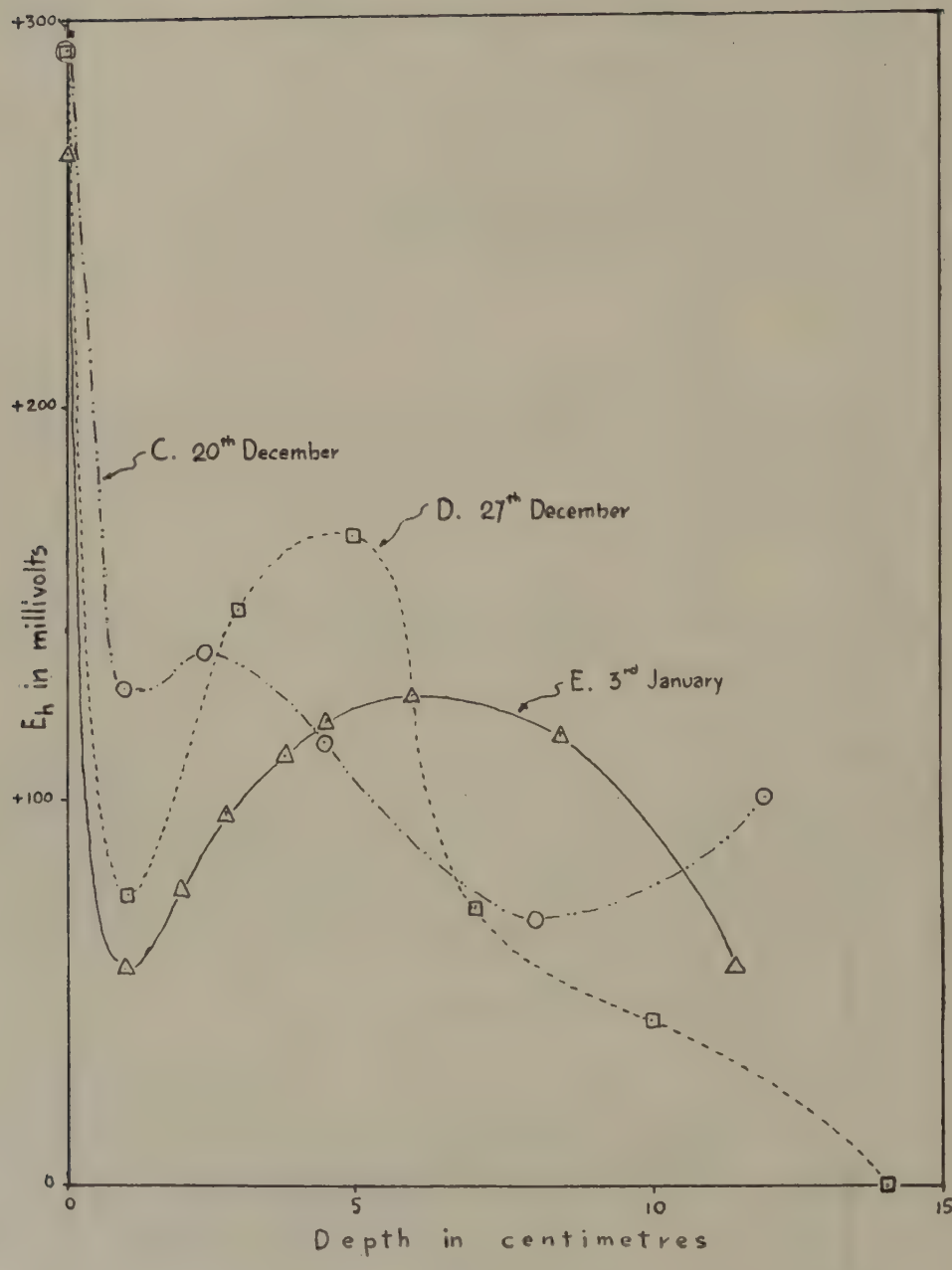
+300
+200
+100
0
E_h in millivolts
C. 20th December
D. 27th December
E. 3rd January
0
5
10
15
Depth in centimetres

Fig. 2

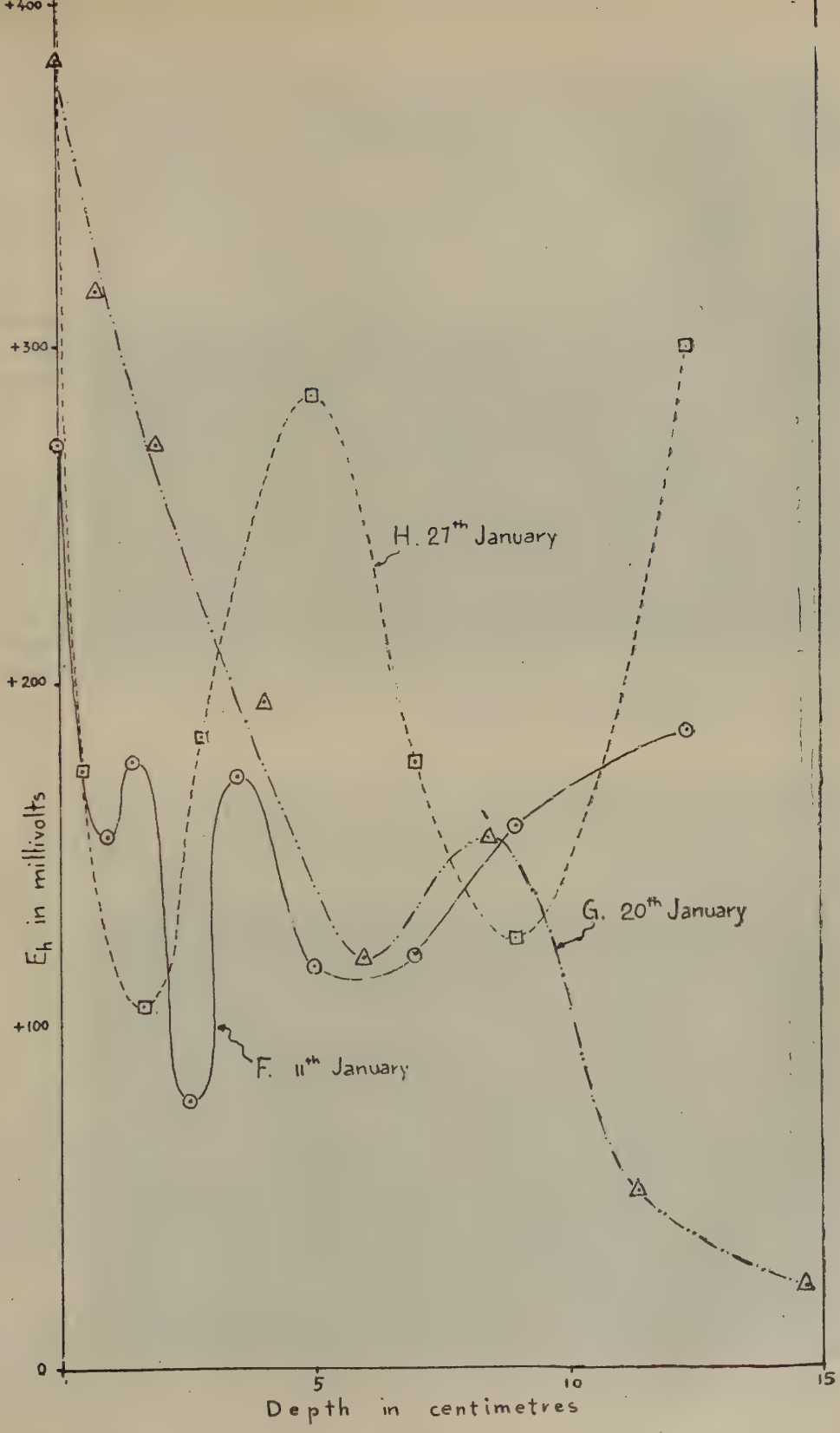
+400
+300
+200
+100
0
E_h in millivolts
H. 27th January
G. 20th January
F. 11th January
5
10
15
Depth in centimetres

Fig. 3

Indian Methods of "Beushaning" the Growing Rice Crop

J. J. NILES

Introduction

IN areas and with varieties in which transplanting is either impracticable or unprofitable, the practice of harrowing the growing crop (Wickramasekera 1940) is widely adopted in Ceylon. The present paper describes comparable methods that have been practised in various parts of India for many decades. Probably the best known of these methods is the one referred to as " beushaning " in Orissa and " biasi " in Madhaya Pradesh.

In India about 70-75 per cent. of the rice acreage is broadcast. In these broadcast areas, three methods of cultivation prevail. In one unsprouted seed is sown dry and the crop is treated later as a wet-land one. This system is comparable to the *manawari* cultivation in the Northern and Eastern Provinces and the *kekulan* cultivation in certain other parts of Ceylon. In another, the dry-sown seed continues to grow as an upland crop, which is similar to the *elwi* cultivation in this country. In the third method, sprouted seed is sown in puddled fields, as it is commonly done in Ceylon. It is in the first and the third methods of cultivation that the crop is subjected to " beushaning " in India. The second type of crop too is sometimes harrowed with an implement called a " bidha ", in which closely spaced iron tines are fixed to a wooden log.

" Harrowing " with the Country Plough

The usual seed rate for a broadcast crop in India is about 80 pounds per acre, but a slightly higher seed rate of about 100 pounds per acre is used where " beushaning " is practised. In this method an ordinary country plough is worked through the standing crop, when the seedlings are 4-8 weeks old, depending on the age of the variety, maintaining about 3-4 inches of standing water in the field. The type of plough used for this purpose in India (Photograph 1) is essentially similar to the country plough in Ceylon. The country plough of course, has no mould-board, does not invert the soil and really functions as a single toothed harrow. In this method of harrowing the growing rice crop, the furrows are run within a few inches of one another. If the stand of the crop is very thick a second harrowing is sometimes done crosswise. While this operation is in progress a team of women follow, re-distributing the seedlings from the thicker to the thinner sown patches. In doing this, the seedlings are picked up with the mud adhering to the roots and dropped in vacant spots as they go along. No attempt is made to erect the fallen plants, except when quite necessary. While on this work they trample into the mud any weeds they come across. It is essential that a few inches of water are retained in the field for about a week after this operation, to help the rice plants to recover and at the same time to submerge the weeds. After about a week, normal irrigation is resumed.

An additional operation which is done in certain parts of India is to run a " beam " or " ladder " over the crop soon after harrowing. This presses down both the rice plants and the weeds, but the former quickly erect themselves, while the latter remain buried. This

PHOTO 1.—A country plough used for " beushaning " in India.

PHOTO 2.—Type of " beam " or " ladder " used for burying weeds after harrowing.

implement, which is more commonly used for levelling the soil, is made up of two parallel beams, each about 6 ft. long × 3½ in. broad × 1½ in. thick, fixed together with a 6 in. space in between them. The implement is similar to that shown in photograph 2. It is worked by a man with a pair of bullocks. In place of this implement, cultivators more often use two bamboos tied together. If necessary the operator rides on the " beam " to give added weight.

Green Manuring Simultaneous with " Beushaning "

A refinement of the " beushaning " technique is the sowing of Daincha seed (*Sesbania aculcata* Pers.) at the rate of 10-15 pounds per acre mixed with the seed paddy (2). As a result of harrowing the standing rice crop, most of the Daincha plants die and those that survive are pulled out and trampled into the mud. The subsequent operation of " beaming " further helps to bury in the Daincha plants more completely. This crop of Daincha produces about 5,000 pounds of green material per acre, when 4-8 weeks old and provides a very good green manure. Daincha has been found useful to reclaim saline lands where other green manure crops will not grow. It is also said to be drought resistant and able to withstand wet conditions (3).

Advantages of " Beushaning "

Varieties that have a sowing-to-harvest duration of less than four months are generally not subjected to " beushaning ". Practically all varieties are stated to benefit by " beushaning " and no differential varietal response has been recorded (4). Top dressing with sulphate of ammonia, if considered necessary, is done at the time of " beushaning ".

This technique facilitates weed control and thins the crop, but all the factors that contribute to the response of this treatment are not fully known. It can be said that one of the factors which gives particular benefit is the incorporation of the surface growth of blue-green algae into the soil. Pearsall (5) has shown that when rice soil is submerged or water-logged, reductive conditions develop and that only the surface layer in contact with air or oxygen-containing water is oxidative. In the flooded rice soils of the tropics luxuriant growth of nitrogen-fixing blue-green algae occurs in the oxidative layer. Hence this surface layer becomes enriched with quantities of easily decomposable organic matter, composed of the cells of living and dead algae. When " beushaning " or similar operations are done, the mixing of the soil layers would, according to Japanese workers, incorporate the easily decomposable organic matter of the oxidative layer into the reductive mass, where it is quickly decomposed by the heterotrophic micro-organisms. As a result, much ammonium nitrogen is produced.

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Phosphatic and Nitrogenous Manuring of Paddy in the Southern Division

D. V. ARIYANAYAGAM

Response to Phosphatic Fertilizers

MANURIAL trials carried out at various stations in this division have shown that paddy responds to phosphatic fertilizers differently at different stations. At Ambalantota Paddy Station four kinds of phosphates (viz., superphosphate, hyperphosphate, saphos and magnesium phosphate) applied at the rate of 30 lb. phosphoric acid per acre for a period of three years (six seasons) had no direct, residual or cumulative beneficial effect on the yield. No response was obtained even in the presence of high levels of nitrogen. At Tissamaharama Paddy Station, superphosphate gave a steady increase in yield of 12 per cent. during the same period. The response was mainly direct. At Udukawa Paddy Experiment Station in the Matara District, a manurial trial was commenced only in *yala* 1953 but the growth of the paddy crop already indicates a very striking direct response to superphosphate.

Response to Nitrogenous Fertilizers

With regard to nitrogenous fertilizers, experiments carried out at Ambalantota Paddy Station for the last five seasons have clearly shown the benefits of manuring the paddy crop with sulphate of ammonia. In the *maha* season the highest yield was obtained by the application of 400 lb. per acre. 100 lb. per acre gave an increase of nearly 20 per cent. over control, and every subsequent 100 lb. gave a further increase of approximately 10 per cent., so that the application of 400 lb. per acre increased the yield by nearly 50 per cent. In the *yala* season, however, the most economical level was found to be 200 lb. per acre, which increased the yield by about 30 per cent. Further appreciable yield increases were not obtained by levels higher than 200 lb. per acre.

Calcium cyanamide proved to be much inferior to sulphate of ammonia at Ambalantota Paddy Station for the last two seasons ; but the growth of the paddy crop this season (*yala* 1953) indicates a definite superiority. The cyanamide-manured plots appear to have made better growth and are darker green in colour than those manured with an equivalent amount of sulphate of ammonia. Response to calcium cyanamide, therefore, seems to be cumulative.

Extra Response to Nursery Manuring

The advantages of manuring the nursery with a complete fertilizer mixture was clearly demonstrated in a trial carried out at Tissamaharama Paddy Station in *maha* 1952/53. Nursery manuring alone (i.e., without field manuring) gave a yield increase of 13 per cent. over control ; field manuring alone (i.e., without nursery manuring) gave an increase of 26 per cent. ; whereas both nursery and field manuring increased the yield by 36 per cent.

BOOK REVIEW

Milk Pasteurization—Planning, Plant, Operation and Control

Prepared by

H. D. RAY, J. R. CUTTEL, H. S. HALL,
A. T. R. MATTICK AND A. ROWLANDS

F. A. O. Agricultural Series No. 23 and W. H. O. Monograph Series No. 14

PASTEURIZATION of milk is now firmly established as a necessity. It must now be accepted that no raw milk can be considered quite safe because even if diseases are eradicated from our cows there is still fortuitous infection from human and other sources to consider.

The perishability of *raw* milk calls for frequent delivery with corresponding higher cost and limits the distance over which milk may be transported for sale. Processes which reduce perishability such as pasteurization and refrigeration are therefore of great value in decreasing milk distribution costs and in enlarging the markets. The latter holds good in the tropics more than anywhere else, and it is well known that one of the main reasons for the very low consumption of milk in Ceylon is the absence of proper facilities for marketing the milk actually produced.

This publication gives a good account of the development of pasteurization and goes on to describe in detail modern methods of pasteurization, equipment and buildings, &c., in common use. Methods of milk control, their importance and legislation are also well described.

The publication which is very well illustrated is certain to be of considerable value not only to those who are engaged in this important section of food preparation but also to those who are generally interested in milk production and its proper utilization. It ought to find a large number of readers also in this country.

A. V. A.

RESEARCH NOTES

Toxic Effects of Feeding *Indigofera Endecaphylla* (JACQ) to Calves

REFERENCES to literature show that in Hawaii, feeds containing 50 per cent. of *Indigofera endecaphylla* (Jacq) fed to cattle cause an increase in the incidence of premature births, dead foetuses and calves which die within a few hours after birth. In unbred heifers there was anorexia, loss of weight, lower conception rate, abortion and nervous symptoms.

In sheep the symptoms of toxicity due to feeding this legume were decreased appetite, corneal opacity, loss of weight, general weakness, unsteady gait, abortion, diarrhoea, purulent nasal and serious ocular discharge and death.

In Ceylon cattle and goats are known to graze on lands where this legume is grown as a mixed cover crop and no ill effects are reported. But with these animals the quantity consumed is well below the amount fed in experiments, and besides they are never on this legume for a sufficient period to develop toxic symptoms.

At the Veterinary Research Laboratory, Peradeniya, daily feeding two six-month old Sinhala bull calves with 10 lbs. of this legume and 20 lbs. grass for 2 weeks caused loss in body weight, increase in the output of indican and the presence of albumin in the urine. Histopathological study showed that there was early damage to the liver and kidneys.

Hormones from the Dung of Pregnant Cows

IN a previous issue of this journal we mentioned that intramuscular injection of an extract from the dung of a pregnant cow induced oestrus in two out of four cows treated. Since then this product was tested in the field and the results are as follows:—

(1) At the Mahaberiatenne Estate Dairy Farm, three heifers and one cow were each given 25 c.c. of the extract intramuscularly. Oestrus was noticed in the cow and two of the heifers within two days of administration. In case of the heifer which did not respond to treatment a second dose of 25 c.c. was given and heat was observed on the second day after the administration. All the animals were served when they were in full heat. Rectal examination after two months showed that the services were successful in the three heifers.

(2) At the Veterinary Research Laboratory two cows were each given 20 c.c. of the dung extract. There was no response for six days. A second dose of 20 c.c. was given again to each of them. One cow came into heat on the second day and the other on the seventh day after administration.

(3) At the Animal Breeding Centre, Nikaweratiya, three cows were each given 20 c.c. of the dung extract. One cow came into heat on the third day.

(4) One old cow at Pelwehera did not respond to two injections of 20 c.c. of the dung extract given at weekly intervals.

From the observation made at Mahaberiatenne Estate Dairy it is evident that the extract from the dung of pregnant cows besides producing oestrus can also cause ovulation in the bovine. Purification and standardization of the product are necessary before we can recommend an effective dosage for cows of different ages to achieve such results.

P. JEGANATHAN.

An Outbreak of Listeriosis in Goslings

LISTERIA MONOCYTOGENES, the casual agent of Listeriosis, is almost world-wide in its distribution and is recognized as a pathogen for a number of domestic and wild animals and man.

The clinical picture and pathological lesions due to infection with this organism varies with the species of host. In the higher mammals it gives rise to an encephalitis or a meningitis, whereas in laboratory animals and birds it gives rise to a generalized infection.

In Ceylon, *L. monocytogenes* has recently been recorded as the cause of heavy losses in a batch of goslings. These birds, belonging to the School of Agriculture for Girls, Kundasale, were hatched out locally from eggs imported from England. Deaths began to occur when the birds were about 3 weeks old. Apart from a gradual loss of condition, no definite clinical symptoms were seen.

Out of nine goslings autopsied, *L. monocytogenes* was isolated from the heart-blood and/or liver of six. Minute necrotic foci in the liver were seen at autopsy.

One gosling sent alive to the laboratory showed a marked lateral curvature of the neck, and tended to walk in circles. This bird was sacrificed for post-mortem examination and *L. monocytogenes* was isolated from its brain, although no mycroscopic lesions were seen in this organ.

It is interesting to note that Listeriosis has not been recorded before in geese or any other water-fowl, and that nervous symptoms due to infection with *L. monocytogenes* have never been recorded in birds. This is also the first recorded outbreak of disease due to this organism in Ceylon.

The strain isolated conformed to the classical description of *L. monocytogenes*. It was found pathogenic to mice, rabbits and chicks, showing characteristic lesions at autopsy.

Most of the reported outbreaks of Listeriosis in birds have been in association with other debilitating factors.

Transmission experiments reveal that birds have a high degree of natural resistance to the organism; and large doses of the organism are required to set up experimental infections.

The present outbreak occurred among goslings hatched out locally from imported eggs. Such birds are generally on a lower plane of resistance and this probably explains why the goslings alone were affected whereas local chicks, brought up under identical conditions in adjoining brooders remained unaffected.

A. BANDARANAYAKE.

Internal Fixation of Femoral Fracture by Intra-Medullary Pinning

This article is a record of the first case in Ceylon of intra-medullary pinning to immobilize a fracture in a dog.

A complete, slightly oblique fracture had been detected in the upper third of a femur, with much over-riding and displacement of the ends of the fractured bone. Intra-medullary pinning had been resorted to on account of the difficulty of applying external splints to the thigh of dogs. The operation was performed two days after the accident. The pin had been left *in situ* for twenty-two days. The animal was able to make normal use of the limb within a period of a month.

The writer is of opinion that this surgical operation is simple and reliable, and relieves the surgeon and the owner of undue aftercare and attention which are required when external splints are applied. The dog tolerates the pin well.

G. E. KODITUWAKKU,
(Abstract from C. V. J. Vol. 1 No.2).

MEETINGS

Central Board of Agriculture

Proceedings of the Fourth Meeting of the Central Board of Agriculture held in the Board Room at the Royal Botanic Gardens, Peradeniya, on 21st September, 1953

Dr. A. W. R. Joachim, Director of Agriculture, presided and the following were present:—Mr. C. A. M. de Silva (Vice-Chairman); Mr. M. Sri Khanta, C.C.S., Director of Land Development; Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production; Mr. A. W. R. Perera, Assistant Commissioner for Development of Marketing; Sir James P. Obeysekera; Mr. S. Pararajasingham; Mr. A. M. Clement Dias; Mr. R. T. Chelliah; Mr. R. H. de Mel; Mr. Marcus S. Rockwood; Mr. Thomas Amarasuriya, Mr. S. Pathmanathan, Chairman, Low Country Products Association; Mr. N. H. Keerthiratne, M.P., and Parliamentary Secretary to the Ministry of Posts and Information; Mr. U. B. Dedigama, M.B.E., R.M.; Mr. Arthur D. S. Jayasinghe; Mr. S. L. Bandara Dharmakirthi, J.P.; Mr. Sydney Ellawala, J.P.; Senator C. Wijesinghe; Mr. A. D. Paranavitana; Mr. Henry Abeywickrema, M.P.; Mr. T. C. Rajaratnam, J.P., U.M.; Mr. J. M. Sabaratnam, D. R. O., Mannar; Mr. K. Kanagaratnam; Mr. S. M. Rasamanickkam, M.P.; Mudaliyar N. M. Abulcassim Marakar; Mr. W. M. Cumaraswamy; Gate Mudaliyar N. Wickremaratne; Sam A. I. Elapate Dissawa, J.P., U.M.; Mr. H. Ashmore Pieris; Mr. H. Abeygoonesekera, D. R. O., Wellassa; Mr. S. Sivapalan; Mr. Kenneth Morford, C.B.E., J.P., U.M.; Mr. A. T. Sydney Smith, J.P., U.M.; Mr. R. Singleton Salmon, M.P.; Mr. S. A. Selvanayagam; Mudaliyar M. M. Ebrahim, M.P.; and Mr. M. Sivanathan, C.C.S., Secretary, Central Board of Agriculture.

The following officials of the Department were present on invitation:—Dr. W. R. C. Paul, Assistant Director (Technical); Mr. C. R. Karunaratne, Agricultural Officer, Dry Farming; Mr. E. Abeyratne, Agricultural Research Officer, Dry Farming.

The following visitors were also present:—Mr. S. B. Yatawara, Agricultural Officer (Propaganda); Mr. M. R. M. Jebaratnam, Assistant Agricultural Officer, Propaganda; Mr. A. H. Imhof (F.A.O.); Mr. L. S. C. Canagasingham; Mr. D. Nillegoda; Mr. H. Wickremasinghe; Mr. S. E. G. Salgado, Lecturer, School of Agriculture, Peradeniya, and Mr. K. Arthur Perera.

Letters and telegrams regretting inability to attend the meeting were received from the following:—Miss Cissy Cooray; Mr. Justin Kotelawala; Mr. H. E. Tennekoon, Land Commissioner; the Director, Coconut Research Institute; Mr. L. S. Boys; Dissawe H. B. Rambukwelle, M.P.; Major E. C. de Fonseka; Mr. A. Hensman; Mr. Gladwin Kotelawala; Mr. A. H. T. de Soysa; Mudaliyar S. Armstrong; Sir Wilfred de Soysa; Mr. G. K. Newton; Mr. N. Rajavarothiam, M.P.; Mr. S. H. Mahadiulwewa, M.P.; Mr. H. B. Samarakoon; Mr. A. C. Ponnambalam; Director of Rural Development; Mr. A. Perumayanar; Mr. M. Senanayake, M.P.; Mr. T. B. Naranpanawe, D. R. O., Ipolegama; Mr. P. B. Bandaranayake; Director of Irrigation and Mr. K. W. Devanayagam.

I—Confirmation of the Minutes of the last Meeting

The minutes of the third meeting of the Central Board of Agriculture were unanimously confirmed subject to an amendment moved by Mr. A. M. Clement Dias, namely, that on page 19 of the minutes, last but the 3rd line, the figure 36 be substituted by the figure 18.

Chairman—"I must express my apologies to you all that there have been three postponements of the date of this meeting. I must take the responsibility for it, although the postponements have been beyond my control. The first date fixed was one which coincided with a meeting of Parliament and a Member of Parliament who was very interested in dry farming wrote in to say that as he would like to participate in the discussion he would wish the meeting postponed. I felt that it would be unfair by a number of Members who would be similarly placed if I did not accede to this request, and agreed to it. On the second occasion, the meeting was fixed for the 7th September which happened to be the date of the Prize-giving at the Girls' Farm School, Walpita, at which the Prime Minister was to preside, and accordingly I, as Head of the Department, had to be in attendance. On the 3rd occasion the meeting was fixed for the 14th September. This coincided with the Arunachalam Centenary Celebrations and a number of members wrote in and asked for a postponement of the meeting. At first I regretted that no postponement was possible but there were so many members requesting it, and in memory of a great man whose centenary was being

celebrated, the meeting was postponed again. That is the reason why we find ourselves here today after three successive postponements and I offer members my apologies for any inconvenience caused.

In the future I think it would be desirable for us to fix the date of the next meeting before we adjourn.

II—Leave of Absence

The Chairman said that two members of the Board, Miss Cissy Cooray and Mr. A. Hensman, have applied for leave of absence from Board meetings. Miss Cissy Cooray had left for America and would be back by the end of November and Mr. Hensman has applied for six months' leave. Leave of absence was accordingly granted.

The Chairman also stated that some members had complained about the non-receipt of the Agenda of the meeting. He said that the notice of the meeting and the agenda were sent out together, and as there was only one item in the agenda some members had probably overlooked this. He expressed regret if any member had not received a copy by error.

III—Matters arising out of the Minutes

" Regarding action taken on the earlier proceedings of the Board " the Chairman stated " we have had, apart from the inaugural meeting, two meetings of this Board at which we discussed the subjects of Food Production and Animal Husbandry. The minutes of the meeting on animal husbandry has only just been confirmed and therefore no action has been taken on these recommendations but in regard to the discussion on Food Production, the position is that I forwarded to the Ministry a copy of the full proceedings of our meeting and had a summary drawn up of the important suggestions and proposals made by members. This was done for easy reference and sent to the Ministry for their consideration. It is receiving their attention. We have had an interim reply on some points but no finality has yet been reached. All I can tell you is this that all our deliberations are being considered by the Ministry and, so far as I am concerned I have made it my special duty to report in full the proceedings and also draw attention to specific proposals made by various members on the different subjects that were discussed. The Minister will now have a full resume of all the proposals that have been submitted on this subject. I hope that when we meet next I shall be in a position to report further on the matter ".

Mr. R. Singleton Salmon, M.P., inquired whether it would be possible to circulate among members copies of the summary of proposals made at meetings which had been sent to the Ministry.

The Chairman agreed to this request.

Chairman—" The main item on the agenda today is a discussion on Dry Farming which will be initiated by the Agricultural Research Officer, Dry Farming, Mr. E. Abeyratne and Mr. C. R. Karunaratne, Agricultural Officer, Dry Farming. Before we start the discussion on Dry Farming I would like, very briefly, to say a few words by way of introduction to this subject.

Dry Farming as you know is not a new line of work in this Department. I have been looking up records on this subject and I find that experiments on Dry Farming date back to 1903. These experiments were started by the Director at that time, Dr. John Willis, and continued by his successors in office. Curiously enough the first Research Station started for dry farming was at Maha Illuppalama, which has again become our Dry Farming Research Station. The original station was closed down in 1919 for some reason or other. But in 1944 it came back to Government having in the meantime been used for the purpose of a sisal-hemp plantation. The Department had all along kept in mind the importance of working out a system of agriculture suited for the dry zone under normal rainfall conditions. In the course of years stations were started in various parts of the country. Apart from Maha Illuppalama, there are stations at Anuradhapura, Jaffna, Ambalantota, Nalanda, Middeniya, Bata-ata, Vavuniya, Unichchai and Polonnaruwa, but most of these were centres where simple experiments were carried out over the years. They gave us extremely valuable information, though not of a precise nature. That was the position till about 1938. Then Mr. Edmund Rodrigo, one of my predecessors, got the happy idea of initiating a dry farming experiment, not from the investigational point of view but from the development point of view. He set up a small dry farming colony of about 100 acres extent. Mr. Karunaratne, of course will give you the whole history of it and will tell you what is being done. From 100 acres this area blossomed out to 700 acres. Mr. Edmund Rodrigo started

his experiment at a place called Kurundankulama, about 4 miles from Anuradhapura. The traditional system of dry farming as you know in Ceylon, is the chena system and it has been the constant endeavour of the Department to replace this system by a more permanent system of rotational agriculture under natural rainfall conditions. The importance of this work demanded that the Department should give full and concentrated attention to it, and in 1950 we appointed a Research Officer solely for the purpose of investigating this problem. We have now four staff officers engaged on the problem of dry farming at Maha Illuppallama where we hope to have a first class research station where the problems of dry farming will be studied from all angles. To help us to solve this problem we asked the F.A.O. for the services of a Dry Farming Adviser and we were fortunate to have the services of Prof. E. A. Hardy for this purpose. He has been with us since 1951 and has helped us a great deal in our efforts to solve the numerous problems which dry farming entails. While we were engaged on this work with Professor Hardy, Mr. Karunaratne and Mr. Abeyratne laying down the foundations of research investigational policy, the New Zealand Government came to our aid by giving us a most generous grant of £ 250,000 or about Rs. 3 million towards the dry farming research scheme. That was in 1952. On this Dry Farming Research Station we are not going to concentrate our attention only on crops. We realize that no scheme of dry farming crop husbandry is going to be successful unless it is combined with animal husbandry. Therefore, in the Research Station at Maha Illuppallama we will study two aspects of this farming, the crop aspect on the one hand and the animal aspect on the other. When one of the representatives of the New Zealand Government came to Ceylon to see what was being done, he initiated the idea that animal husbandry research should play an important part in our scheme of dry farming. But we found that we would need more money to give full effect to this plan. The new proposal was put up to the New Zealand Government and I am in the happy position to tell you, that they have given us a further grant of £ 250,000 for the purpose. This means that the New Zealand Government has given us over Rs. 6,000,000 towards the initiation of work on dry farming research in all its aspects, including the animal husbandry aspect.

I would here, on behalf of the Board of Agriculture, express to the New Zealand Government our thanks for their most generous grant towards the solution of an extremely important problem in Ceylon's agriculture. We have about 3 million acres of highland which cannot be irrigated according to the Irrigation authorities, and these have to be utilized to best effect. The Rs. 6 million grant which the New Zealand Government has given us will serve as the foundation on which this great development will take place.

I have now presented to you a general survey of the position in regard to the problem of dry farming from the administrative point of view. I will now ask the two officers concerned to speak to you from the technical angle. I am sorry that Professor Hardy is not here today, otherwise he would have participated in the discussion and given us his views of the problem. I will not take any more of your time and will call on Mr. E. Abeyratne, Agricultural Research Officer at Maha Illuppallama to talk to you on dry farming from the investigational and research point of view ".

IV—A Talk on Dry Farming by Mr. E. Abeyratne, Agricultural Research Officer, Maha Illuppallama

" Mr. Chairman and Gentlemen—I propose very briefly here to discuss firstly the problems relating to the area under dry farming and then the problems of dry farming themselves. It is well established that very high and stable crop yields may be obtained under irrigation and where irrigation water is available, there is no better system possible in any country. However, there is a limit to the extension of irrigation set by the available water resources of any country and in Ceylon that limit is now being reached. When almost all the ancient irrigation schemes have been restored and with the completion of Gal Oya, Walawe Scheme and the Malwatte Scheme, there will hardly be any extension possible. The Land Utilization Committee has estimated that between two to two and a half million acres of unirrigable land in the dry zone will be completely out of reach of irrigation water and if we are to meet the increasing demand for food and satisfy the land hunger that now exists, it is absolutely essential that this dry land should be tackled somehow or other.

There are four ways of tackling this problem:

(1) By the cultivation of animal crops and encouraging animal husbandry;
(2) By establishing pure animal husbandry;
(3) By afforestation;
(4) By the cultivation of permanent fruit and economic crops.

At the moment the talk is food and more food and any system that will help us in achieving this situation is what should be aimed at. Dry farming can be defined as that system of farming which is possible in the absence of irrigation using rain water. The first question that comes into my mind is, where in the dry zone is this dry land available, how is it distributed and what are its present uses and what use can it be put to in order to meet our demand for food. Before any discussion on dry farming is undertaken it is necessary to review briefly the existing patterns of settlement and agriculture in the dry zone with a view to indicating where unirrigable land suitable for dry farming is distributed.

Characteristics of the Dry Zone

The Dry Zone comprises that region of Ceylon in which there is a prolonged dry season with a rainfall of less than twenty inches during the months April to September. During this period rivers go dry and water is scarce. In spite of an annual rainfall of 50 to 75 inches, therefore, water is the limiting factor to the extension of human settlement. The dry zone comprises 2/3rds of the Island and with Matale as the centre, can be roughly taken as the Northern Province, North-Central Province, part of North-Western Province, part of Uva, Eastern Province and Southern Province down to a little east of Tangalle. (Mr. Abeyratne indicated this area on the map.)

The contributory causes are:

(1) An unevenly distributed and often unreliable rainfall. (This was illustrated by a map.)

(2) Absence of extensive underground water supplies.

(3) Relatively shallow soils and sub soils with low water storage capacity.

(4) High temperatures and strong winds during the dry season with the resulting high rates of evaporation and transpiration. An evaporation rate of 1/3rd of an inch per day is the average for the dry season at Maha Illuppallama.

All these factors combine to make life in the dry zone absolutely impossible till about mid September. That is why the ancient people utilized all their energies on water conservation. The system of development adopted in the olden days is absolutely perfect in the line of water conservation and no further improvement on that system is possible. The system of village tanks and major irrigable schemes developed by the ancient people is too well known to need description." Mr. Abeyratne illustrated by means of a map a section of the Malwatu Valley to show the connection that that pattern of tank villages had with the extension and development of dry farming in Ceylon. Mr. Abeyratne continued " In order to meet the water supply for agriculture, there are two ways of doing it. First to conserve all the water that falls on land and divert the water from surplus areas into the dry zone. This system is somewhat similar to the ancient system of tanks.

The first method of total water conservation was developed to a high degree in the ancient days and the pattern of settlement based on tank villages will remain unchanged as long as no water is diverted from outside into any given region and no underground supplies of water sufficient for irrigation are available. In the second method, similar to the modern colonization schemes of Kagama, Minneriya, Parakrama Samudra and Gal Oya will result where nearly all the land is made irrigable.

From a point of view of dry farming, we have to start using each of these village units as a base. There is no alternative. The first step should be that the uncultivated land that is now in waste should be given a water supply and if we did that we will end with a system like the ancient system of irrigation villages. Dry farming development therefore becomes a scheme for the creation of new villages and the development of existing ones. From our dry farming point of view we start with the existing village units and from that view point it is necessary to study normally the structure of each of these villages, and roughly the problems of one village will apply to others as well. Similarly if we are to concentrate our attention on water conservation, the next problem that we have to tackle will be each river valley as a unit.

The dry zone consists of a large number of river valleys having similar climatic, topographic and agricultural conditions and with the exception of the Mahaweli, Walawe and Gal Oya, the rivers in all these valleys dry up during February to September. Underground water supplies are also very short and some provision for a continuous water supply is necessary if people are to live and grow crops in the area.

Most of the dry land in the dry zone is under forest but in the villages dry land is cropped under the traditional system of chena cultivation. The main problem of dry farming therefore is to place the chena on a more stable basis. From a point of view of long term fertility maintenance there is no better system than the chena but this practice has no survival value for economic reasons. Population pressure is increasing rapidly and it is not possible for any country to spare so much land for each family. In a chena cycle of cropping once in ten years, ten times more land would be required than if the land was cropped continuously. "

Pointing out to the map, Mr. Abeyratne said that on the other side of the Gangoda tank in which region the water table is high, chena cultivation was going on and the valley bottom was cultivated with paddy. Most of the irrigable low lands in that region were cultivated with paddy and the unirrigable land with chena and drought susceptible crops like coconut, and citrus where the water table was high. He added " We concentrated our attention on these highlands. Most of it is now under jungle and in villages under a system of chena. Our problem therefore is a very large one. It is one of replacing this chena with a more suitable system.

Problems of Dry Farming

Crops. A tradition for dry cropping therefore already exists and a start was made at the Experimental Station, Anuradhapura, in 1935, with growing the regular chena crops under a system of settled arable farming using crop rotations. It was found that good yields of cotton, chillies, maize, kurakkan, cowpea, green gram and black gram and more recently groundnut, dhal and sorghum could be obtained in an average year of rainfall. The results at Kurundankulama also indicated that this type of farming offered some prospects, provided a number of problems were solved. There was for example considerable difficulty in weed control, erosion was heavy and soil fertility tended to be rapidly lost but all in all, climatic conditions could be considered suitable for the production of dry crops. Other means of raising a living from dry land by animal husbandry by foresting and by the production of permanent fruit and tree crops need investigation. Emphasis at Maha Illuppallama is on the production of food crops and animal husbandry. From 1946 onwards, dry farming work was transferred to Maha Illuppallama and from 1950, it had got intensified.

When a chena cultivator abandons a piece of chena and moves on to another piece of jungle, he does it mainly because he finds it difficult to control the weed growth and rather than tackle the weeds in his chena, he prefers to open up a new block of jungle. We found that by clearing the land successively it was possible to control weeds for a year or two during which period we got good crops, but after that the cropping came to a standstill. The next point was that it was not possible to grow on every piece of highland the same crops.

Land Classification

At Maha Illuppallama and Kurundankulama it was experienced that all the dry land was not suitable for the production of cotton, chillies, sorghum, groundnut, maize, cowpea, &c. They tended to fail in certain areas and succeeded in others. At Maha Illuppallama we began to study this question of land classification. We came up against this problem, that since almost all the land in the dry zone were in small valleys and there was no flat land, there was a tendency for most of the dry crops to fail in the lower regions due to water logging and bad drainage.

At Maha Illuppallama perforated pipes were sunk to rock depth at sixty points over the Research Station and water-table heights were measured twice a week in each pipe using an electric probe. Location of the holes (' Water-table gauges ') in one of the catchment basins (basin C) on the station is given in figure 3 and the data on the mean monthly heights of the water-table in these pipes in table 1 and graphs 1 to 6. "

(This was explained and illustrated by Mr. Abeyratne by means of maps and charts.)

" It will be observed that there was no water-table at the water shed and upper slopes of the basin (gauges 14, 15, 18-21 and 24), while at the middle and lower slopes the water-table which was within six to eight feet of the surface during the rainy season fell sharply during the dry season. Gauges (13, 17). At the valley bottom the water-table remains more or less near the surface, falling more slowly during the dry season (gauges 11, 12, and 16). This year (1952/53), was a year of unusually low rainfall and by comparison the heights of the water-table recorded in pits in 1951/52, are also included in graphs 3 to 7. The water-table rose to within 3-4 feet from the surface at the water shed and upper slopes pit No. 5, graph 6, while on the slopes it was on the surface for short period and fell slowly, pit No. 1 and 4, graphs 3 and 5. At the valley bottom the water-table remained near the surface throughout the period during which the records were kept pit No. 2, graph 4.

Water-table behaviour is affected by rainfall as the figures above show. In 1952/53, only 15 inches were received from September to January, while in 1951/52, 47 inches were received. (Illustrated in table 1.) The fact that the overburden is only 15-40 feet thick would account for this rise in water-table during the rainy season. Table 1 includes the depth of rock below the surface in the bore holes in the catchment basin C. Elsewhere on the Station the rock lies at the depths of 15-40 feet and this is typical of a good part of the dry zone. Water-table behaviour is an important factor and has to be reckoned with in planning cropping systems in so far as its effect on drainage is concerned. With relation to water-table behaviour these three classes of land can be distinguished within each catchment basin.

(1) Land in which the water-table is not likely to influence cropping except in exceptionally wet years. Water shed and upper slopes.
(2) Land in which water-table rises to near the surface during the rains and falls rapidly during the dry season, lower slopes.
(3) Land in which the water-table remains near the surface for a greater part of the year—bottom lands.

The influence of irrigation tanks and channels has also to be taken into consideration. Generally the effect of a tank channel is to reduce the fluctuation in water-table level during the year in land in the vicinity of the tank. This introduces a fourth class in which the water-table remains stable, fluctuating only with the level of water in the tank.

If dry crops are to be grown on land on the type (2) and (3) drainage is a vital factor.

Experience with other areas has also shown that each catchment basin has a similar water-table pattern and from a point of view of drainage each basin has to be treated as a unit. Within each catchment basin there appear to be definite land classes related to water-table behaviour in which slightly different management problems are posed. Systems of land use suitable for each class of land have to be worked out ".

Mr. Abeyratne then explained the significance of soil colour and the close relationship that exists between soil colour and water-table behaviour by means of a map.

The following is an extract from his address:—

Soil Colour

" Figure 3 shows the soil colours in catchment basin C. Reference to table 1 and graphs 1 to 6 will show that a very close relationship exists between soil colour and water-table behaviour. Information collected so far points to the fact that textural and soil structure differences also occur between the land classes.

Detailed studies are in progress. Starting from the water shed of a catchment basin, profile studies down to the depth of a decomposing rock were made at points down the slope of the catchment in the representative land classes. A record of the detailed description of the soil horizons in these profiles was made, to be correlated with date from the chemical analysis of the soil and clay fractions from these horizons. The organic matter and Ph determinations, and the mechanical analysis of the soil from the respective horizons have been completed. The complete analysis of the soil S102, Fe203, AI203 TI02, P205, Ca0, Mg0, Mn0 and K2 are in progress.

Scheme of Land Classification

Four land classes have already been distinguished. It is considered necessary to separate the water shed from the upper slope as soil depth on the water shed is usually shallow and rock out drops occur very frequently.

In the dry zone most of the bottom-land is irrigable and a further distinction is made between irrigable and unirrigable bottom lands. Based on the factors considered above the following tentative scheme of classification has been drawn up to serve as a starting point in the study of land classes.

I. *Unirrigable Highlands*

(1) Watershed. Well drained, needs special erosion protection. Is best left under forest.
(2) Upper slopes. Relatively well drained, needs expensive soil conservation measures, disposal of storm water is necessary for raising dry crops during an average Maha, is best suited for dry crops.

II. *Unirrigable Lowlands*

(1) Lower slopes need drainage particularly in very wet years. Drainage is likely to be expensive. Disposal of storm water is necessary for cropping during the Maha. Appears to be more suitable for Yala cropping. Soil conservation measures similar to the upper slopes.

(2) Bottom lands. Needs expensive drainage systems if dry crops are to be grown. Land is flat and soil conservation measures need not be as elaborate as on the slopes.

(3) Lower slopes in the vicinity of tanks. Here the water-table is relatively high. A certain amount of drainage is needed. Suitable for drought susceptible tree and fruit crops.

III. *Irrigable Lowlands*

Land is generally flat and cultivated with paddy. No special soil conservation measures are required.

Maintenance of Soil Fertility

METEOROLOGICAL OBSERVATIONS

The mean daily evaporation from a free water surface, mean soil temperature at 4″ and 12″ depth under natural grass and the mean wind speed at twenty feet during the months March to September are shown in Table II ". (These tables were shown and explained.)

Mr. Abeyratne continued—" The next step was to suit crops into each of these classes of land. We are now trying to grow crops on the upper areas, fodder and vegetable in the middle slopes and paddy on the bottom lands. Taking the problem of cultivation itself, the rainfall during Maha is very intense. We get 35 inches of rain between October and January and these storms are very intense. We have recorded 1 inch of rain in 12 minutes and 4 to 5 inches in 24 hours. This means we have to grow crops spaced fairly close. Otherwise we expose the ground to tremendous erosion. There are two kinds of erosion. The first, resulting from rainfall which tears down a hill forming gullys. The second is the impact of the rain drops on the area year after year ultimately ending up with an area of loose sand and crops become almost impossible on such land.

To overcome this, a system of graded terraces is recommended. At Maha Illuppallama gully erosion has been controlled by a system of graded terraces discharging into a central storm drain located along the natural drainage line. By far the most serious source of erosion is the erosion caused by the impact of rain drops on a bare soil surface. Soil aggregates are broken up and the most valuable part of the soil, the clay, is carried away in the run-off water. At the same time we found that by any method of weed control we were intensifying the amount of splash erosion. So that, we had to solve these two problems of weed competition and prevention of erosion. For this purpose three experiments were started at Maha Illuppallama.

The first was where we grew between main crops a fast growing legume which covered the ground and checked weeds and there was weed control.

The second experiment was planting on ridges.

The third was growing cover crops at the tail-end of a season and allowing it to continue for the next season.

In the first experiment we found that the yield of chillies had declined by about 95 per cent. In the second set of experiments in the financial year 1950-51, we found that by growing on ridges, we got the biggest yield. In 1951 we had a rainfall of 27″ fairly well distributed. In the next year we had a rainfall of 47″, but the yield on the ridges had declined by 27 per cent. In the 3rd year we had only 15″ of rainfall and the yield on the ridges had again declined by 30 per cent. That was because when we cultivated ridges, the yield tended to fluctuate with rainfall. The third method of growing cover crops at the tail-end of a season was very promising and we got a yield of about 900 cwt. of cotton. Further there was absolutely no weeds and erosion was almost completely stopped. That line of work is being continued and we are growing Velvet bean during the tail-end of a season and allowing it to remain right through the year.

On the dry land there is an appreciable loss in soil fertility with continuous cultivation. Using green manures and legumes to maintain yields evidently is not very successful. At the moment there is very little information available as to how one can permanently maintain yields. For example if soil fertility is to be maintained as done in the chena system, one would need ten to fifteen times more land and it is not

possible to continue with this chena system for long. We are now investigating the possibility of resting the land for a short period under grass, secondly under small trees and thirdly under legumes. We are keeping a check on the effect of this form of soil structure and soil fertility and it is not possible at this stage to make any conclusive recommendations in that respect. We have found that a rotation with cotton in the first year, groundnut and gingelly in the Yala and sorghum in the 3rd year mixed with Tur Dhall is fairly satisfactory. Rotation trials designed to investigate the effect of different cropping sequences and duration of cropping and rest periods are also under study. There are some fertilizer trials also carried out and we hope that in about two to three years time we will have some information available.

On the question of designing of implements to suit local conditions, I must say that almost all implements imported from overseas are not entirely satisfactory for our purposes and Mr. Templeton is now working on the designing of these implements to suit our conditions.

We are introducing a large number of fodder experiments and food crops with a view to finding out something better than what we already have. At the moment we are concentrating on cash crops like cotton, chillies, Tur Dhall, cowpea and black gram. We hope that within the next two years we shall have something definite to report on.

In conclusion I would like to say that over 50 per cent. of the village tanks in the North-Central Province have a very precarious water supply. Paddy cultivation is liable to fail in many years. In Yala and in Maha, cultivation is very, very limited. The solution of this dry farming problem itself is a measure of relief and would contribute to the prosperity of these villages because at the moment their standard of living is very low and their living conditions dreadful. Conditions in most of these villages are deplorable and if dry farming can be taken up in these villages, there is a prospect that the standard of living will improve ".

V—A Talk on Dry Farming by Mr. C. R. Karunaratne, Agricultural Officer, Dry Farming

" Mr. Chairman and Gentlemen—The Agricultural Research Officer has given you an account of dry farming research activities ".

Mr. Karunaratne then read the following :—

Acreage of Ceylon. The total area of the Island is 16,200,000 acres ; of this only 3,500,000 acres are under cultivation with tea, rubber and coconuts, paddy and highland chena crops.

The remaining area of nearly 12,725,000 acres may roughly be grouped as follows :—

(*a*) Roads, streams, tanks, towns and villages	1,250,000	acres.
(*b*) Forests including National reserves and sanctuaries	3,500,000	,,
(*c*) Rocky and steeplands and lands over 5,000 ft., &c.	4,750,000	,,
(*d*) Balance available for future expansions	3,225,000	,,

It will thus be observed that we have an extent of about 3,225,000 acres which is not being put to any productive use. Of the total area of 3,500,000 acres under cultivation, 2,800,000 acres are in the wet zone and only 700,000 acres are in the dry zone. In contrast to this most of the land available for further agricultural development are in the dry zone. Thus any further extensions of agricultural activities lies primarily in the dry zone.

The Dry Zone of Ceylon may loosely be defined as that part of the island where the annual rainfall is less than 75 inches per annum.

The Wet Zone is approximately bounded—

on the North—by the Deduru oya,
on the South—by the Walawe ganga,
on the West—by the Sea,
on the East—by the foot hill of the hill country.

Lands outside this area constitute the dry zone and forms about $\frac{3}{4}$ of the area of Ceylon (Northern Province, N.-C. P., part of N.-W. P., S. P., E. P., and low country of Uva). Most of the lands lie up to the 500 foot contour and consists of gently undulating land forming river catchments.

Climate and Rainfall of the Dry Zone

The total annual rainfall of the dry zone is less than 75 inches. Its distribution gives rise to two clearly marked seasons. About 75 per cent. of the rains fall in torrential showers during the months of October, November, December and January—during the Maha season, and about 20 to 25 per cent. during the months of April and May. Occasional scattered showers fall between February and March and June to September. Rainfall during the Maha season is always effective and storms of great intensity are frequent.

Dry South-Western winds blow across the area from June to September. Damages to unprotected crops and wind erosion are appreciable.

The character of the rainfall in the dry zone determines its pattern and system of agriculture and natural vegetations. There is rapid vegetative growth during the Maha rains from October to January. Lands cleared during the preceding dry season is covered with weeds, vegetation and secondary jungle. The main cultivation season takes place during this season.

Soils of the Dry Zone

These are shallow, compact, hard and relatively impervious. The soils are difficult to handle and become highly impermeable after rain and require very careful and skilful handling. The frequency of rains during the seeding season are such as to render intercultivation almost impossible due to the wet conditions with the result that weeds develop luxuriously.

There is a striking difference between the dry areas in India and in Ceylon. The rainfall in the dry areas in India ranges from 20 to 25 inches as compared to three times that quantity in Ceylon. But the Indian soils are deeper and more porous and water penetration is quicker ; the frequency of showers is such as to allow implemental cultivation and weeds do not present such a serious problem as in Ceylon.

Conservation of Water in the Dry Zone

We do not, unfortunately have any water bearing strata except in the north and parts of North-Western Province. During the dry season the underground water table lies at 30 to 40 feet below the surface of the ground. Most of the rivers and streams dry up. Life in the dry zone is impossible without storing and conserving water, particularly during the dry season.

The ancient people of the country realized the importance of stored water. Two systems were adopted by them for conserving the abundance of water dispersed over the plains during the rainy seasons.

One was to utilize and harness all the water that fell on a local catchment and effectively enbanking its outlets, thus giving rise to numerous village tanks.

The other was the more scientific and ambitious which was effected by constructing massive anicuts across rivers and turning the water through excavated channels. So careful were the people in utilizing these water resources on which their existence depended that even the surplus water from one tank which would spill when water was plentiful were not allowed to escape. The tanks were built in orderly method at slightly varying elevations, so that there often was a series of reservoirs to take the overflow of the one above it.

In this manner the face of the country came to be thickly dotted with these reservoirs. Paddy was cutivated in the irrigable areas and permanent crops were grown near the tanks. The surrounding unirrigable land was utilized for cultivating dry crops under rain fed conditions. This appears to have been the system of village settlement and the natural development of the dry zone. If water from outside can be used to augment supplies in smaller tanks or where no source of water is available, as it is over the greater part of the dry zone, then the existing pattern of tank village settlement must remain unchanged.

Chena Cultivation

When the ancient civilization broke down and the tanks went out of commission, the inhabitants of the dry zone were compelled to adopt the chena system of cultivation for lack of a better system.

The chena cultivator rotates the land instead of the crops. The advantages of this system to the dry zone villager are :—

(*a*) little equipment and no cattle are required ;
(*b*) accumulated fertility of number of years is utilized for the crops ;
(*c*) weeds are almost absent during the first year.

The success of chena system of agriculture depends entirely on the possibility of allowing the cleared forest to regenerate into its previous conditions before it is cleared again for a chena. As the population increases the chena cycle has necessarily to be reduced. This is already happening. It is not uncommon to see forests cleared at intervals of 3 to 5 years. The chena system becomes very destructive when a certain density of population is reached. Some authorities rate this density of population at 130 per square mile. The population density of the dry zone is about 120 per square mile. It is rapidly increasing and it would appear that we are approaching the danger point if we have not reached it already, considering the low rate of forest regeneration under our conditions of soil and climate.

The chief difficulties the dry zone villagers are confronted with to embark on an economic system of arable farming are:—

(*a*) age long custom ;
(*b*) lack of ownership of land ;
(*c*) ignorance of tillage operations, implements and animal husbandry ;
(*d*) inability to develop and render the land arable without financial assistance ;
(*e*) inability to purchase the necessary tools, equipment and draught bulls without assistance in the form of long-term loans.

There are at present in Ceylon about 200,000 of land in the dry zone which have been chenaed and cropped as chena. It is thus very clear that one of the most immediate and important problems facing the country is the replacement of the chena system by a stable system of rainfed cropping. It was in this perspective that Mr. Rodrigo, a former Director of Agriculture, envisaged the development of a stable rotational system of dry farming when he started the settlement scheme at Kurundankulama in 1938, and it is no exaggeration to state that this experiment is a land mark in the history of Ceylon Agriculture.

Dry farming implies the cultivation of arable crops without irrigation by utilizing the rainfall and moisture in the soil to the fullest advantage. The crops have to be cultivated according to the adaptability and suitability of the land, that is correct land use.

Kurundankulama Dry Farming Scheme

This was started by the Department of Agriculture in 1938 on an irrigable block of 100 acres at Kurundankulama, 4 miles east of Anuradhapura and the Trincomalee Road with the object of—

(*a*) Ascertaining whether the Wanni villager with guidance and assistance could be trained to take up to dry land arable farming on the land developed and rendered arable as a suitable substitute to his traditional chena cultivation.
(*b*) To ascertain the extent of unirrigable land an average peasant family could farm efficiently using simple bullock drawn implements and the income that could be obtained therefrom.
(*c*) Whether the fertility of the soil could be maintained under the prevailing conditions of intense rainfall during the comparative short rainy season, and long spells of drought and high temperatures.

Attempts to secure ten typical Wanni families proved futile owing to the natural conservation of the Wanni villager to abandon his home. Only one typical Wanni family was recruited. Nine other families made up the settlement of ten families in January, 1939. Some other selected families either abandoned their allotments or were weeded out for bad work.

The block of 100 acres was divided into 10 equal allotments one for each family, the first acre with the road frontage being used as the homestead. The development of the allotments was done in stages, beginning from January, 1938, and completed by 1943. It was the intention to clear and stump progressively each year an extent that each family could develop. A subsistence allowance of Rs. 15 per month was paid until the whole allotment was rendered arable.

Very soon the department realized that it was beyond the capacity of the settlers, while struggling for an existence, to develop their holdings expeditiously. The department thereupon developed and rendered the holdings arable at state expense, the settlers themselves receiving wages for the work done, thus supplementing their income when the production from partially developed holdings were insufficient for their needs.

Each family had a wattle and daub house and a latrine, a cattle shed and poultry run, on the homestead acre. This acre was planted up with citrus, mangoes, jak, breadfruit plants, &c., and interplanted with bananas. A small area was also set apart for vegetables. Eight wells were provided for the entire settlement.

The remaining 9 acres were cropped according to the following rotation:—

Block A—6 acres

1st year	...	Maha—Chillies
		Yala—Pulses
2nd year	...	Maha—Cereals
		Yala—Gingelly
3rd year	...	Maha—Cotton
		Yala—Cotton continued.

Block B—3 acres

1 acre—Bananas for five years
1 acre—Napier Grass for five years
These two crops to be rotated.

Block C—1 acre—permanent paddock. Each settler was given a pair of draught bulls, one cow, a pen of poultry and essential bullock drawn implements and tools. They worked their allotments individually while an Agricultural Instructor stationed at the scheme advised them. The development of all the 10 allotments were completed by 1943, each allotment costing Rs. 4,100.00.

In 1945 the department planned another dry farming scheme at Makalanagama in North-Western Province, about three miles from Galagamuwa on the Ehetuwewa road. This scheme was different to that of Kurundankulama in that the land was soil conserved on the catchment basis; farming on a co-operative basis was introduced and a part of the area was rested under a grass fallow instead of continuous cropping, thus weaving in live stock to the plan. This implied the use of the land alternatively for arable crops and raising live stock for a period of about 4 years and thereafter changing over.

The Kurundankulama experiment produced satisfactory results, and in 1947-1948 the settlement was extended by the addition of 84 acres to be farmed co-operatively by six families. The entire area was cleared and rendered arable, and permanent cottages constructed at state expenses. Each family was allotted 14 acres made up as follows:—

2 acres for the homestead to be worked individually;
6 acres for arable farming to be worked co-operatively for 4 years;
6 acres to be utilized for stocking for 4 years, thereafter to be ploughed up for arable crops.

The 84 acres block was divided into three, the middle block being used for the homestead and the front and rear blocks for cropping and stocking. They farmed 36 acres co-operatively and utilized 36 acres for stocking their animals. The settlers selected happened to be a heterogeneous crowd and by 1949 three were weeded out for bad behaviour and better type of peasants were recruited.

About this time, i.e., end of 1948 it was noticed that there was sense of frustration, discontent and dissatisfaction among some of the settlers of the original 10 families, whereas others appeared to be quite content and happy. Their grievances were looked into and were found to be genuine and justifiable. The system of farming had to be altered and improved.

The topography of the land these ten settlers farmed was fairly typical of the dry zone of the N. C. P. being slightly undulating with valleys in between. About 20 per cent. of the land was water-logged and ill drained. Arable crops could obviously not be grown in these water-logged areas. Thus the settlers who were unfortunate to cultivate these low-lying water-logged blocks were decidedly at a disadvantage. There were four such settlers and this group was naturally disgruntled and discontented when they looked around to see other members of their settlement who had allotments more favourably situated were reaping good crops. They also realized that the second group of settlers farming co-operatively were progressing and all of them raised good crops. The chief cause of the trouble was unequal distribution of suitable land for arable farming, and the necessity for soil conservation on a catchment basis.

In 1949-50 the old settlement was given an entirely new turn. The whole settlement was resoil conserved on the catchment bases with broad based graded bunds, all the run off from the catchment being harnessed in an abandoned tank which was restored. The low-lying areas were contour ridged with broad based bunds for paddy cultivation as a rainfed crop.

10 new permanent cottages were constructed in group form on a hillock, allowing 2 acres as homestead per settler to replace the wattle and daub cottages that were constructed in 1938. A new service road was constructed to serve the new group of cottages and the two groups of settlers. One irrigation well 38 feet deep and 30 feet in diameter was provided for the 10 settlers.

The next step was to even off the inequalities of the distribution of land for cultivation by converting the settlement into a co-operative farming unit. The settlers who were farming favourably situated fertile blocks simply jibbed at the idea and refused to agree, whereas the less fortunate ones welcomed it. By considerable persuasion coupled with sternness the 10 settlers eventually agreed to farm co-operatively commencing from 1950-51 season.

Their units of allotment and systems of cropping were changed. Each settler was given 2 acres homestead instead of one acre, and 12 acres for farming co-operatively on the alternate system of husbandry instead of 9 acres to be worked individually and cropping continuously. Old fences were removed and the entire block fenced separating the cultivated blocks from the resting blocks for cattle. The rotations were modified and crops were cultivated according to land capacity, i.e., correct land use, cropping along the contour interraces or bays was introduced. Low-lying areas were cultivated with paddy as a rainfed crop.

The Rotation now being practised is—

1st year	...	Maha—Cereals—Sorghum, Kurakkan mixture and Dhall
		Yala—Sorghum ratooned—Gingelly
2nd year	...	Maha—Chillies
		Yala—Chillies
3rd year	...	Maha—Cotton
4th year	...	Maha—Pulse mixture with Dhall spaced widely
		Yala—Gingelly.

The broad based bunds to be planted with Tur 5 dhall. To enhance their incomes the settlers can cultivate vegetables during the Yala season by lift irrigation during favourable seasons.

Thus two groups of settlers commenced farming co-operatively, one group of 6 settlers and the other 10. Each group selected its own leader or gamarala. The selection of the leader is done annually before the commencement of the Maha cultivation season. The leader of each group or unit takes instructions and follows their leader in all the co-operative farming operations. The leader acts under the guidance and directions of the Agricultural Instructor-in-charge of the settlement.

The 10 settlers that embarked on the new venture of co-operative farming after about 10 years of farming their allotments individually happened to be a heterogeneous crowd and they found difficulty in pulling together. At the end of the season of their own accord they requested that their group be split into two units of five each. Their request was granted and the land was blocked out accordingly.

A co-operative store established on the farm was revived and reorganized. All the settlers obtain their provisions from this store.

The total produce harvested by each co-operative unit is divided between the settlers according to the labour units contributed by each family. One labour unit is earned by one man working one day. Three-quarter labour unit is earned by a woman, or by a boy or girl between 14-16 years working a day, and half a labour unit by a child between 14 and 16 years working a day. The leader maintains a record of labour units for each family of the unit.

Extension of Dry Farming Schemes—Kurundankulama and Relapanawa encouraged with the result of the Pilot Settlement Scheme of Kurundankulama

In 1950, the Ministry decided to open two dry farming schemes to settle 40 families at each. Two sites were selected in consultation with the Revenue Officers. One site was at Kurundankulama, the extension covering an area adjoining the already established dry farming scheme. The advantage of this area was

that a very large extent of land was available in the triangle formed by the Anuradhapura-Trincomalie Road, Anuradhapura-Kandy and Mihintale roads. It had the added advantage that it was four miles from Anuradhapura.

The second site selected was close to Relapanawa village, 13 miles from Anuradhapura on the Anuradhapura-Puttalam road.

Development of the land

The clearing of jungle, stumping, rooting and cross-rooting, levelling anthills, construction of roads and restoration of abandoned tanks at Kurundankulama were done by the Land Development Department with machinery—D8 tractors, with bulldozers and rooters, while at Relapanawa these operations were done by the Agricultural Labour Corps with machinery and with labour. As the Agricultural Officer was in charge of the two schemes, all these operations were done under his supervision. All the colonists' cottages, latrines, wells and the general buildings such as the school, School Masters' quarters, Manager's and Conductors' quarters, meeting hall, co operative stores and dispensary were constructed by the Land Development Department.

The entire planning and lay out of the whole scheme, siting and demarcating wind belts, siting of tanks, ponds and groups of cottages and general buildings, tracing of the network of roads, soil conservation on the catchment basis, fencing, &c., at both the schemes were done by the Agricultural Department under the directions of the Agricultural Officer and his field staff.

Provision of Wind Belts and Fuel reserves

Belts of forest, 300 feet to 500 feet wide spaced every 2,000 feet to 3,500 feet apart were left along the ridges to serve as wind breaks and as fuel reserves. The space between any two wind belts depends on the topography of the land. The undergrowth of these wind belts have to be cleared leaving intact all valuable timber trees and other trees with good spreading crowns. Uneconomic and useless trees such as Veera can be exploited for firewood and the gaps planted up with useful trees such as Halmilla, Teak, Mango and Cashew. A large number of Halmilla seedlings have been planted in the wind belt and along the fences at Kurundankulama and at Relapanawa. Of about 10 per cent. have survived at Kurundankulama and about 5 per cent. at Relapanawa. It is proposed to plant an appreciable number of Teak and Cashew seedlings with the Maha rains in 1953.

Restoration of abandoned Tanks

Several abandoned and breached tank bunds in varying stages of disrepair were found in almost every catchment at both the centres, seven at Kurundankulama and six at Relapanawa after the land was cleared and the jungle burnt. All the thirteen farm tanks were restored by filling the breaches and widening and raising the bunds by heaping the soil excavated from the beds in the process of deepening. This was done with heavy earth-moving machinery. In addition to these an abandoned pond measuring about 100 feet in diameter was restored at Relapanawa.

Soil and Water Conservation

The cleared area was soil conserved on the catchment basis with broad based graded bunds. Fields in the valleys that get water-logged during heavy rains were soil conserved with broad based contour bunds for cultivation of paddy as a rain fed crop during the Maha season. The storm water drains leading from the ridges were diverted to the tanks. All the run-off water from each catchment was harnessed and stored in the tanks. The aim was not to allow any run-off from the area cleared to find its way outside before being harnessed and stored in the various tanks situated in the different catchments within the scheme. The water stored in these tanks apart from the beneficial effects of gradual raising of the water table, would be very useful for domestic and stock purposes, and for cultivation of vegetables, etc., during the yala season.

Lay-out

The 80 homesteads of 2 acres each—40 at Kurundankulama and Relapanawa respectively have been grouped in units ranging from 4 to 9 houses, each unit being provided with a common well 15 feet in diameter and 30 feet deep. All the homestead units have been located on the upper reaches of the farm tanks.

Barbed wire fences have been erected round the perimeter of the homestead units and round the blocks to be cultivated co-operatively by the colonists. The blocks to be cultivated co-operatively are divided into two sections, one section for the cultivation of crops and the other for resting and stocking (pasture for cattle). The blocks carrying crops of paddy are also perimeter fenced. Kapok, Halmilla, Mangoes and ornamental avenue plants have been planted along the fences to serve as replacements for fence posts later on, but owing to the severe drought experienced this year the strike has been poor.

Buildings

Each allottee is provided with a type plan cottage, a latrine and a temporary cattle shed. One temporary shed is also provided for each unit to serve as a store to keep carts and implements and also to store the produce of their co-operative blocks as these are harvested.

It was very unfortunate that the roof work of all the cottages have been constructed out of ordinary jungle round timber instead of using sawn timber. This was presumably due to the temporary shortage of sawn timber at the time of constructing these buildings. The roofs are thatched with cadjans. It is however gratifying to record that the defect has now been rectified by tiling these cottages.

Amenities

A separate block of about 10 acres has been reserved at each centre for a school for the allottees' children, quarters for the school master, co-operative stores, dispensary and a meeting hall. All these buildings have now been completed and are functioning. The co-operative stores are functioning at both the centres.

Quarters are also provided for an Agricultural Instructor and for a conductor and an office cum circuit bungalow at each scheme.

Acreage and Make up of each Scheme

	Kurundankulama (extension) *Acres*	*Relapanawa* *Acres*
Gross acreage opened up	1,068 ..	677
Number of farm tanks restored	6 ..	6
Allowance for tanks at full supply level	34 ..	40
Wind belts	225 ..	60
Roads and drains	12 ..	5
General buildings and quarters for officers	12 ..	12
Acreage actually cultivated..	448 ..	320
Acreage rested for stocking..	336 ..	240
	1,068 ..	677

Selection of Allottees

It was decided to give preference and priority in the selection of allottees (to these two schemes) to landless married men who had undergone training at the various practical Farm Schools maintained by the Department of Agriculture. A special Land Kachcheri notice was drawn up for the dry farming schemes by the Land Commissioner in consultation with the Agricultural Officer, Dry Farming, a copy of which is attached.

Land Kachcheries were held at Colombo, Galle, Matara, Kegalla, Kurunegala, and Anuradhapura. The response was very disappointing as most of the married candidates that were eligible for application were already employed as Food Production Overseers, Demonstrators, Administrative Secretaries of Co-operative Agricultural Production and Sales Societies. With a view to giving those still unemployed a further chance,

the marriage qualification was not enforced and fresh land Kachcheries were held when 39 passed out students were selected from various parts of the Island. Twenty-three allottees for the remaining 4 allotments were selected from landless peasants, priority being given to those residing in the North-Central Province.

Some of the cottages were not ready for occupation until the end of November, 1951.

At the end of December, 1951, sixty-two allottees had been selected and were residing in the allotments as detailed below:—

District	*At Kurundankulama*	*Relapanawa*	*Total*
Passed out students from Kegalla District ..	16	9	25
Passed out students from Kurunegala District	4	1	5
Passed out students from Kandy District ..	1	—	1
Passed out students from Kalutara District	2	—	2
Passed out students from Colombo District	1	1	2
Passed out students from Matara District ..	4	—	4
Peasants from N. C. P.	—	23	23
	28	34	62
Vacancies to be filled by peasants ..	12	6	18
	40	40	80

Out of the 39 passed out students selected 32 were bachelors and 7 were married. The bachelors arrived with a helper or two as instructed to, but in most of the cases the helpers left them after a short time leaving the bachelor allottees to carry on single handed. This work as such was by no means an easy task with the result that they endeavoured to attend to the homesteads and neglected the Co-operative Units.

Strenuous efforts were made by the visiting and resident officers at persuading these " students " allottees to settle down to work. Their helpers would perhaps have not left them had these care-free bachelor " students " allottees refrained from adopting a superintending attitude. When the helpers left, these allottees expected the crop of certain units sown for their use as they were late to take up residence, to be also gathered and delivered to them at Government expense. Even the valuable grafted and other plants supplied free for planting in their homesteads were neglected. A scrutiny of the records of yields and the income derived from the sale of crops is glaring evidence against the degree of their efforts in comparison with the sober allottee who had crying mouths to feed. Twenty-two student allottees unfitted for this type of work left the allotments before they were expelled, and all the vacancies were filled by landless peasants from the North-Central Province and from Matale North.

By the end of August, 1952, all the allotments were occupied and the set up was as follows:—

	Kurundankulama	*Relapanawa*
Passed out students—Married ..	6	1
Passed out students—Bachelors ..	7	3
Landless peasants ..	43	36
Total ..	56	40

Scheme of Work

Each allottee is given 14 acres of land of which 2 acres are for his homestead to be worked by him and his family individually The remaining 12 acres form part of the undivided portion of the land, held in common by the unit or group, to be farmed co-operatively by all the members of that unit. Out of the land held in common by the unit for co-operative farming, half of the extent would be farmed co-operatively by all the members of that unit and the remaining half would be rested as grazing ground for all the cattle belonging to the members of that unit. For example, if a unit is composed of 6 families, the total extent of land allotted to them would be 84 acres. Of this, 12 acres would be utilized for the homesteads at the rate of two acres per family. The remaining 72 acres would be farmed co-operatively by the six families, 36 acres being cropped for four years and the remaining 36 acres being rested as grazing ground for their cattle. After four years there would be a change over, the ploughed or cropped area would be rested and the rested area cropped.

The allottee's cottage lavatory, cattle shed, poultry house, compost pits, &c., are situated on the homestead. The block is utilized as follows:—½ acre under Java kapok, ¼ acre under banana, and ¼ acre under vegetables. Bananas and vegetables are to be rotated once in four years. The remaining area is planted up with fruit trees and intercropped until the fruit trees develop. The boundaries of each homestead are separated by live fences of Murunga and Katurumurunga plants.

Each allottee works his homestead on an individual basis and is personally entitled to the produce of his labour. He can dispose of his produce according to his own wishes if he so desires. This system has the advantage of combining the co-operative and individualistic elements.

Each unit elects its own leader or gamarala once a year before the commencement of the Maha cultivation season. The leader guides the members of his unit, maintains check lists of labour and records of produce harvested, and settles as far as possible petty quarrels and disputes among the members of his unit. He represents his unit as a member of the working committee of the society. He is advised and guided by the resident Agricultural Instructor who is the Manager of the Scheme. He is paid a bonus of 1 per cent. from the gross income of each member of the particular unit for services rendered.

Two co-operative societies were formed, one at each centre in 1952. These were not registered until all the allotments were occupied and the population became static after the departure and expulsion of those who were ill-fitted to the tasks. In September, 1952, the two societies were registered as (1) Kurundankulama Dry Farming and Sales Society, Ltd., (2) Relapanawa Dry Farming and Sales Society, Ltd.

The resident Agricultural Instructor who is the Manager of the Scheme functions as President and Treasurer of the Co-operative and Sales Society at each centre. Each Co-operative Society maintains a provision store for the benefit of its members who are given credit facilities up to a fixed limit. This has prevented them from falling into the clutches of the local traders.

These are two unique societies, the only two of its kind in Ceylon.

Every allottee is a member of the Co-operative Society. Every member has to cultivate the allotments in accordance with the planned programme and rotation laid down by the Dry Farming authorities. They have to conform strictly to all the regulations laid down by the Land Commissioner in allotting land to them. Any livestock issued by Government to the Society is in turn loaned by the Society to its members. No member is allowed to maintain more than 6 head of cattle, 8 goats and a flock of poultry. All progeny raised from such foundation stock will be the property of the member who raised such progeny. All the produce from the Co-operative units and preferably from the individual homestead allotments as well are to be disposed of through the Society.

It is the duty of every group of members of a unit to maintain in proper order and in good condition all roads, drains, avenues, fences, pasture blocks, wind belts, farm tanks and ponds. Whenever the members have failed to attend to these, the Society will, after due warning, execute this work by engaging outside labour. Such expenditure will be deducted from the particular group.

If through the negligence of the members any damage is caused by fire or cattle to crops, buildings, fences, etc., such members will be liable to pay as decided upon by the committee the cost of the damage to the particular unit or the individual member concerned.

The Society maintains and controls all issues made by Government such as draught bulls, cows and other livestock, carts, seed drills, intercultivator ploughs, disc harrows, etc. These are in turn loaned or issued by the Society to each unit or member for specified periods of work, in some cases on hire, as may be decided by the working committee.

Each member has to maintain in good order his cottage and lavatory and his cattle shed. Where a member fails to do this, the necessary repairs will be effected by the Society and the cost charged to his individual account. All the general buildings will eventually be maintained in good condition by the Society.

No member is expected to be away from his allotment at any time without informing the leader. Before leaving his homestead he has to make adequate arrangements with the leader for the proper care and maintenance of his livestock and house. The leader in turn informs the President. The leader cannot absent himself without informing the President.

The standard of cultivation will be done to the satisfaction of the dry farming authorities. Any allottee or group of allottees that fail to maintain a good standard of cultivation or are found to be indifferent farmers or violates or attempts to violate any of the conditions of the permit or any instructions given by

the Dry Farming Authorities will have the permit cancelled and the allottees will be compelled to quit their allotments and leave the settlement altogether. No such allottee will have the right to claim any compensation from State on any grounds whatsoever.

Every member has to pay a land tax at the rate of Rs. 10 per acre per annum for every acre under cultivation. This will be Rs. 80 per annum.

The work of the farm is normally performed by the members of the Society while assistance is only resorted to when it is necessary to call in hired labour to supplement the full labour strength of the Society during rush work.

The President maintains a check roll showing the labour turn out of every member. At the end of the season a complete statement showing the labour days earned by each member is exposed for two weeks at the President's office before the day of the general meeting at which the distribution of the income of the farm is to be decided.

The division of the divisible income is done strictly pro rata according to the labour units earned. In reckoning labour units, a man is reckoned as 1 unit; a woman $\frac{3}{4}$ unit; a boy or girl between 16 and 18 years as $\frac{3}{4}$ unit; children between 14-16 years as $\frac{1}{2}$ unit. All the harvested produce from each co-operative unit are handed over to the Society stores. These are valued and the price to be paid per labour unit is arrived at. Each member is then paid after making the following deductions:—

(*a*) Land tax and seed reservation for the following year;
(*b*) Payment of any cash loans, seed loans, work hired out by implements and machinery and for any other work done by the Society on behalf of the member; foodstuffs supplied on credit by the co-operative stores;
(*c*) Payment of 1 per cent. of the gross income as bonus to the leader of the unit for services rendered:
(*d*) A deduction of 2 per cent. of the gross income for a Reserve Fund. The cash will be deposited in the Co-operative Bank. This reserve fund will be for assurance against crop failures, etc. This reserve fund is indivisible.

The success of the co-operative schemes of this type depends largely on the selection of the correct type of settlers. Progress at the two major dry farming schemes at Kurundankulama and Relapanawa suffered very appreciably during the first year as a result of recruiting unmarried passed out farm school students most of whom were ill-fitted for this type of work. The officers managing these schemes should essentially be very human minded, patient and tolerant, mix with settlers freely, listen to their woes and complaints patiently and at the same time be firm. The measure of success achieved so far is largely due to the officers managing these schemes possessing these qualities. They, as pioneers, have had an uphill task which they have discharged so far admirably well.

Most of the old settlers plough and prepare the land for seeding with bullock drawn ploughs as their bulls are well trained and the settlers have the necessary experience. The newcomers, however, were unable to prepare the land in time owing to their inexperience and the plough animals being not sufficiently well trained with the result that the land was tractor ploughed for them on payment at the rate of Rs. 24 per acre for ploughing and harrowing. With the formation and registration of the two Co-operative Societies and discussions at the general meetings and meetings of the managing committee, the outlook of the settlers has changed. They now feel that they have a deep sense of responsibility and that the Society is responsible for their well being and advancement. They have realized the importance of timeliness in preparatory cultivation of arable crops in the dry zone. Two Fordson tractors with ancillary equipment, one for each Scheme, were made available by the Director of Food Production in February, 1953. The managing committee controls the programme for working the tractor on hire. Each unit submits a requisition to the committee outlining the works to be done on hire for their units. After completing the work in the settlement the committee hopes to undertake ploughing of lands on hire within a radius of about five miles round the settlement. They have on their own initiative decided and agreed to pay the leader a bonus of one per cent. from their gross income for services rendered. They have also decided to hire out the bullock drawn disc harrows to the members of the settlement at the rate of twenty cents per day.

One difficulty that was experienced at the early stages in working the co-operative unit was in respect of the output of work by each member. The more efficient and hardworking felt that the others could not keep pace and wasted their time to cover up the number of hours. They readily agreed to a system of

payment according to the quantity and quality of the work done. The Managing Committee will draw up a work day task standard or quotas of work of operations on the settlement to be done by men, women and children. A work day will be credited to the farmer only if he fulfils the set quota in its entirety. If he does not complete the quota he will get less credit, while on the other hand if he does more than the quota he will receive more credit proportionately. The quality of the work will be considered as well as the quantity.

The system of payment for labour in accordance with quality and quantity will give every member, a direct material interest in the results of his work, and will be one of the best means of encouraging a high level and improvement of labour productivity in co-operative dry farming schemes. The system will be started from Maha season 1953-54 onwards.

Development of Dry Farming Schemes in Villages in the Dry Zone

Apart from establishment of Dry Farming Colonization Schemes the question of extension of these schemes to existing villages deserves full consideration. Here it will be a problem of expanding and converting an existing established village into a planned system of agriculture.

A village or hamlet in the North-Central Province and possibly in other parts of the dry zone too can be considered as a cluster of ill-ventilated huts, with hardly any compounds for cultivation, and generally situated below the bund of the village tanks. During the rainy season the village becomes a quagmire due to the seepage from the tank and also due to the low-lying situation of the village.

They cultivate a portion of their paddy fields each season, the exact acreage to be cultivated depending upon the quantity of water stored up in the village tank. For their highland crops they chena Crown land often far away from their homesteads and thus eke out a precarious existence. Their cattle are allowed to roam about, invariably damaging other cultivations.

Land is not essentially the limiting factor for development of village agriculture in the dry zone, but it is water. The stored water in the village tank can be considered as the very life blood of the village community, without which life would not be possible.

Therefore the most important work to be undertaken should obviously be to harness every drop of water and to store it in the village tank by:

(*a*) Raising the bund where necessary;
(*b*) Diverting streams where available into the tank;
(*c*) Repairing the structures, spills and sluices, etc., and if possible deepening these tanks. Deepening is suggested not for irrigation but utilizing the water for domestic and stock purposes.

The next consideration may be planning of the village allowing one to two acres per family for the homesteads and providing the necessary amenities. The houses constructed according to a type plan to suit the district, may be located on the upper reaches of the tank.

The next stage would be the introduction of dry farming methods in place of the existing system of wasteful chena cultivation. The development of the land for dry farming will be on the same general principals as recommended for the present colonisation schemes. The land to be selected for this should be immediately around the homesteads, on the upper reaches of the tank.

In view of the fact that the villagers would be cultivating their own paddy fields, the unit of land for dry farming may be smaller, say a minimum of seven acres including one acre for homestead (as against 12 acres excluding the two acre homesteads for the dry farming colonists).

The 7 acres may be utilised as follows:—1 acre for homestead and 6 acres for cultivation of which 3 acres will be cultivated for 4 years and the balance 3 acres rested for stocking for 4 years and thereafter changing over. The system of providing for stocking is very important to prevent the cattle from straying about and thriving at the expense of cultivations belonging to others.

Well planned Dry Farming Units may be established in villages. Schemes of paddy cultivation cum dry farming in units of individual villages, as envisaged, worked as far as possible on co-operative lines under sound directions, would stop wasteful destruction of forests, increase the standard of living of the villagers, step up production and improve their livestock by a process of grading up. Thus each village can be considered as a self contained unit. Such a scheme will maintain a natural balance of cultivated land and forests.

This system of planned and settled agriculture can be established in the numerous new village expansion schemes started a couple of years ago particularly in the North-Central Province and more recently in Matale North, to start with.

The villagers will fell, clear and burn the jungle without assistance. In view of the fact that Crown lands are to be developed, full cost of stumping, soil conservation on the catchment basis, sinking of wells, levelling anthills, construction of tanks and ponds and laying out of roads may be borne by the State as this would by an investment by the State in the development of land belonging to the State and in the well being of an agricultural community which would be the backbone of the country.

Expenditure to be incurred for construction of houses, fencing, purchase of implements and equipment, live-stock, cultivation loans, etc., may be on long term loans from C. A. P. & S. Societies.

Dry Farming Scheme—Olukaranda

This dry farming scheme is situated three miles from Kekirawa—near the 61st mile on the Kekirawa-Anuradhapura road. The land selected happened to be an abandoned village named Rattagala Halmillewa, adjoining Olukaranda village in Kalagampalata of Nuwara Kalavia in North-Central Province.

A part of this land had been used as a military camp during the last world war. The attraction for this site apart from its favourable situation was the presence of two big irrigation wells with unlimited supply of water, constructed by military authorities. These two wells supplied water to military camps at Habarana and Sigiriya, about twenty miles away.

Clearing operations commenced on the 18th of May, 1950, and approximately 100 acres were cleared, stumped, soil conserved on the catchment basis with broad based bunds fenced and an abandoned village tank restored. Five cottages were constructed and a well for domestic purposes built. Three landless families from Ihalagama village in N.-C. P. and two from Central Province who had migrated into N.-C. P. were settled. The five families formed a population of 44. The same extents and system of co-operative farming as at the other two major schemes were adopted at this centre.

In 1952 two more families were settled thus bringing the total to 7. A co-operative credit society was registered in 1952 to provide credit facilities to the settlers in the form of cultivation loans, etc., and thus free them from the grips of local traders.

The tank that was restored earlier was deepened and the bund strengthened in 1952. An extent of about three acres below the tank was levelled and ridged for paddy. Besides these an extent of about 8 acres of low-lying land in the valley was levelled for paddy as a rain-fed crop during the Maha season and for raising vegetables, etc., during the Yala season with lift irrigation from the irrigation wells. A centrifugal pump driven by an engine will be installed for this purpose.

The incomes obtained by these settlers since they commenced farming are tabulated below:

Year	*No. 1*	*No. 2*	*No. 3*	*No. 4*	*No. 5*
1950-51 ..	.. 1,375·78	.. 1,388·14	.. 1,337·02	.. 1,424·01	.. 1,216·73
1951-52 ..	.. 1,246·28	.. 1,589·22	.. 1,348·43	.. 1,459·01	.. 1,078·44

Settlers Nos. 1 and 3 had mortgaged their paddy fields for Rs. 250 and Rs. 150 respectively before they joined the scheme. Both of them redeemed their mortgages from the income obtained at the end of the first year.

Settlers No. 2 purchased a small plot of land at Olukaranda for Rs. 150 and also purchased a push cycle for Rs. 200 for his son to attend school, from the income obtained at the end of the 2nd year.

Settler No. 5 purchased a push cycle for his son to attend school from the income obtained at the end of the 2nd year.

Dry Farming Scheme—Makalanagama

This scheme is situated 2½ miles from Galgamuwa on Ehetuwewa Road in Wanni Hatpattu in the North-Western Province.

The extent of about 300 acres was cleared in 1944 when the writer was functioning as Agricultural Officer, North-Western Province. The entire area was rendered arable, stumped, soil conserved with graded bunds on the catchment basis and the acreage between each bay surveyed and computed. Five abandoned tanks within the cleared area were to be restored.

In 1945 a dry farming scheme was started to test the possibilities of Co-operative farming on the alternative suggestion of husbandry by settling villagers from already established villages in the district without recruiting colonists from other districts.

The system of co-operative farming was later adopted at Kurundankulama in 1948.

The land was divided into two units with 7 homesteads on each. The writer left the Division when the cottages were being constructed and before the scheme started functioning. With the formation of the Dry Farming Division this scheme was handed to the writer in July, 1952.

Chairman: "Gentlemen, you have heard two papers on Dry Farming one from Mr. Abeyratne on the fundamental problems relating to a successful system of dry farming and the investigations that have been carried out towards the solution of some of them. The other was Mr. Karunaratne has told you something about the practical application of this scheme in areas which are thought ideally suited for this type of agriculture. Now we will be happy to have from members their points of view on the subject and any questions they would like to ask."

Mr. N. H. Keerthiratne, M. P. and Parliamentary Secretary, Ministry of Posts and Information inquired whether records of trials carried out after the Maha Illuppallama Research Station was opened in 1903 was available and whether the speakers could enlighten the Board as to why it was considered necessary to close down that station in 1919. He added that his viewpoint was that instead of starting trials all over again, it would have been better to start where trials and investigations had stopped on the earlier occasion.

Mr. Keerthiratne also stated that he would like to know what permanent crops were recommended in those dry farming villages as a result of investigations carried out; what the average income of a Vanni village family was and the breed of the two bulls and the cow allotted to a village family and whether they were imported animals acclimatized to the Vanni conditions.

Mr. Keerthiratne also inquired whether all the trees were uprooted when the land was cleared for cultivation, because in the villager's method of clearing land, he did not uproot all the trees.

Chairman: "In regard to the question of the Maha Illuppallama Research Station which was opened in 1903, we do not have full details of the records of trials carried out at that time but we have annual reports of the Department covering that period. We know from their findings that cotton was tried out on this Station and did fairly well in some seasons but not in others. We have there a coconut plantation which was started in 1903 and is producing fairly satisfactorily. We have records that sisel hemp was started on this station, but it is not possible to make a success of the crop unless it is cultivated on a very large scale. Therefore we should not judge experimental work carried out 50 years ago in the light of our experience today. A number of experiments have been carried out and we are trying to get more detailed information from them."

Mr. Keerthiratne: "I would kindly ask you, Sir, that in future records of all experiments be preserved in a library or some such place for future reference."

Chairman: "I can assure you that at the present time full records of all our experiments are kept and are available for reference."

Mr. Abeyratne: "As regards records I can say that full detailed records are maintained for all our experiments and these records are not only maintained for reference but results of certain experiments are published.

In regard to permanent crops, the position is that if there is no water stored artificially, there is no water in the sub-soil. If you do not store water in the sub-soil for a number of years and if the water on the surface is allowed to drain off, it is not possible to build up a water table and it is not possible to grow any kind of dry arable crops like coconut, plantain, papaw, etc. The ancient people realised this and that is why they built several tanks for storing the surface water and also a series of reservoirs were constructed at lower elevations to take the overflow of the ones above them. Mr. Abeyratne explained further by reference to the several maps which were got up by him for the purpose.

Mr. Ashmore Pieris inquired how much of land was allotted for the homestead and what acreage was utilised for arable crops and also what was cultivated in the homestead area?

Mr. Karunaratne replied that at Kurundankulama, land was allotted to each villager as follows:—

2 acres for the homestead to be worked individually,

2 acres for arable farming to be worked co-operatively for 4 years,

6 acres to be utilised co-operatively for stocking for 4 years, thereafter to be ploughed up for arable crops.

He added that bananas, napier grass, chillies, cotton, gingelly, sorghum, ground nuts, kurakkan, dhall, etc., were cultivated and permanent trees like halmilla, kapok, teak, etc., were grown along the fences. The two-acre homestead area was planted up as follows:—

½ acre under kapok,

¼ acre under vegetables,

¼ acre under bananas.

Bananas and vegetables were rotated once in three or four years. The remaining area was planted up with fruit trees and other permanent trees.

In reply to Mr. Keerthiratne, Mr. Karunaratne said that sixteen allottees were given Scindi cows and twelve allottees were given Black Sinhala cows and that they would be crossed with Tharparkar bulls.

Referring to a question by Mr. Keerthiratne about the uprooting of trees when a holding is cleared for cultivation, Mr. Karunaratne said that usually three to four trees were left behind in each acre cleared.

Mr. Keerthiratne inquired whether the Department had endeavoured to give the youngsters (children of the colonists) in these dry farming villages a training in the different methods of cultivation, use of new implements, etc.

Mr. Karunaratne replied: "We have not come to the stage when the children of these colonists are sufficiently big enough or old enough to be able to give them a training in agricultural practices."

In answer to a further question by Mr. Keerthiratne, Mr. Karunaratne said that the average income of a colonist worked out to about Rs. 2,000 a year, exclusive of all vegetables and produce consumed by them.

Mr. Ashmore Pieris: "I suppose you grow citrus on the highlands in these areas?"

Mr. Karunaratne: "Citrus has not done very well in that area. I think about 60 per cent. of the trees die during the severe drought.

Mr. Ashmore Pieris: "In areas like Bibile and Moneragala citrus does well and that is also a dry zone area, and these areas are even considered feasible for poultry. How could you explain why citrus does not do well in the dry farming villages?"

Mr. Karunaratne: "I quite appreciate Mr. Pieris' point of view. Bibile is essentially a citrus growing area where the soil is deeper and there is a better rainfall more evenly distributed. Mango has instead proved to be very successful in the dry zone and we have encouraged poultry in these mango orchards, but unfortunately due to religious prejudices, all are not keen on poultry farming."

Mr. Ashmore Pieris: "Could I know your experience in Yala cultivation in these areas? I think Dr. Rhind sometime ago told me about his experience, and not to grow anything in the Yala season and that it would be better to rest that land entirely in Yala and grow during Maha."

Mr. Karunaratne: "Yala cultivation in the dry zone is really a gamble. We grow gingelly, tur dhal and sun hemp during the Yala season."

Mr. Marcus Rockwood: "I am inclined to think that there are too many experts. We cannot get away from the fact that dry farming as practised in countries like the U.S.A., parts of South Africa and Australia cannot be adopted here. I consider that the water requirement, whatever the crop may be, under methods of dry farming, should be more or less the same as that required for the same crop in wet areas. Hence I consider that the essential conditions to make a success of dry zone cultivation are a good subsoil, abundant supplies of water within a reasonable distance from the surface, temperature

of such a nature that would not scorch the earth during the greater part of the year, and an absence of winds which not only dry up the little moisture in the soils but also carry away during certain seasons fine particles of good earth.

There was no doubt that the dry zone should come under the plough to meet the demands for food by our increasing population, but other methods have to be found. It is not that such methods were unknown to the cultivator. These same tracts were cultivated successfully a few hundred years ago. Now under the guise of dry farming, experts, I believe, are recommending the successful methods of long ago under the kings of old.

What we now want is not experts, but the will to make every tank, irrespective of size, to function up to 100 per cent. efficiency. Then our dry zone will flourish and produce the goods. We have our own men, give them all the assistance, for they know more of the subject than any foreigner can teach them. Put them on the job without the semblance of any political background."

In regard to soil erosion to which reference was made in the course of the discussion, Mr. Rockwood believed that by strip cultivation a certain amount of erosion could be avoided.

In regard to the implements which were being designed by a foreign expert, Mr. Rockwood said that once the investigations were over, all the implements should be turned out in this country.

Mr. Rockwood also stated that he hoped that the Rs. 6,000,000 which was received from the New Zealand Government would be utilised for the restoration of tanks and " not go down the drain ".

In regard to the question of growing citrus in the dry zone, Mr. Rockwood said that his experience was that citrus could not be grown in lowlying areas where there was water logging, nor could it be grown in areas where there was not sufficient water and moisture in the soil.

Senator C. Wijesinghe inquired about the co-operative method of farming adopted by the colonists, whether the produce is commuted in cash according to the number of labour units engaged by each family. He also inquired if out of five such farms, two had failed, whether the people who worked the latter would also benefit irrespective of the results of the crop.

Mr. Karunaratne replying to an earlier question by Mr. Rockwood, stated : " I might point out that regarding water requirements of dry zone crops, Mr. Rockwood made us understand that unless water is available from underground reserves it will not be possible to raise crops satisfactorily. The fundamental requirement here is that water has to be conserved in the catchment. At Relapanawa, the colonists and villagers had to go about five miles for water. It would surprise you that I had to dig eight wells, each well about 30 feet deep and I had 16 ft. of water. It was entirely due to the conservation of water in the catchment that this was possible.

In answer to the points raised by Senator C. Wijesinghe, Mr. Karunaratne stated: " In our dry farming schemes we have no absentee landlords. Every member of the Co-operative Society works on the farm.

Regarding the distribution of labour units and the value for their produce, all crops that are harvested are handed over to the Co operative Society Stores. They are not expected to sell any produce outside. Crops once handed over are valued and it is divided according to the number of labour units put in by each family. In addition to this a two per cent. deduction is made as a reserve fund against famine, old-age, etc."

Referring to Senator Wijesinghe's question about the extent to which the colonists would be affected in the event of a failure of crops, Mr. Karunaratne said " Rainfall in the N.-C. P. is quite effective though once in about ten years we get a bad season. So far we have not come across any difficulty by way of a failure of crops."

Senator Wijesinghe: " Do they get a living wage?"

Mr. Karunaratne: " It would surprise you that after meeting all family requirements, most of these colonists have been investing their money on bicycles, gramophones, etc., so that their incomes are sufficient to keep them going.

Gate Mudaliyar Wickremaratne referring to the Chairman's introductory speech stated that it was not a case of dry farming but the desire to raise some economic crops in that part of the country. He added that the then Governor of the Island being desirous of developing that unused land and raising some crops, in this instance cotton, directed the then Director of the Royal Botanic Gardens (Dr. Willis) to make investigations. Dr. Willis accordingly selected Maha Illuppallama for the purpose. Cotton was grown

at Maha Illuppallama without success. Later on, during the time of Mr. F. A. Stockdale (later Sir Frank Stockdale) sun hemp was tried out at Maha Illuppallama which too was a failure and Maha Illuppallama was given up for a time. Gate Mudaliyar Wickremaratne continued: "I wrote to the Director of Agriculture to take up the question of dry cultivation to find out whether there are any chances of raising the production of food in this country. That was about ten months ago. Now I am glad that I heard at this meeting two of your officers who have been working at it have seen for themselves the results without depending on experts. As Mr. Rockwood said dry farming is quite different from raising crops in the dry areas. The question is whether we can raise crops for food purposes in the dry zone. New Zealand, Australia and America, they have their different soils and different climates. Even in India the soil is quite different to ours. Our soil in the N.-C. P. has been neglected for about 800 years. By that time the cultivated lands in other countries have been improved year after year and their soils are improved. But in the case of Jaffna, owing to the continuous cultivation of land with the addition of leaf and other matter to the soil, the Jaffna soil is quite soft and porus."

The other difficulty about dry farming is water logging as Mr. Abeyratne explained. I have always been impressed by the work done by people who lived in this country in the olden days. They built reservoirs and took water from rivers into reservoirs. From the reservoirs they sent down the water to smaller village tanks, so that these village tanks created a water table for the crops. Therefore to establish that water table in these dry areas, the same old system has to be adopted and we must not speak about dry farming in this country. Our country is placed in its natural setting with hills at the centre and plains all round. Therefore we have rivers right round like the Mahaweliganga which feeds an enormous area throughout its course. I read in the papers that Relapanawa area was cleared and that six tanks were found in that area. These tanks are watered from Kalawewa. If you can trace the irrigation officers who were present they will say how I have been going through that tracing in 1912. We have rivers all round and those rivers are getting silted. I felt very sorry when I heard that the Relapanawa area was being cleared. Why should we now think of dry farming? The only thing that we can encourage in dry farming is our pulses. But pulses can be grown as a rotation with other crops. We need not have a special dry area for that type of cultivation. What I say is, do not clear these forests unnecessarily. I suggested sometime back the method of preservation of water and how it should be done. At that time one of the European planters, Mr. Wilkinson, wrote to me that he has been in Ceylon for 50 years and that the present tendency was to make the Island a desert. You must all try and prevent it. When we have village tanks, why don't we utilise them. Therefore the only way to save this country and work for its progress is to restore all reservoirs, tanks and village tanks and give them to cultivators.

Regarding the question of encouraging sheep and goats and finding the land especially for goats, I fear that when we do not have sufficient land for paddy, we cannot have extensive areas for goats and sheep. We must go back to our old method of cultivation and not worry about dry farming. We must improve our tanks, village tanks and prevent our rivers getting silted, so that the people of this country will be benefitted."

Mr. S. Pathmanathan, Chairman, Low Country Products Association inquired whether the rental of Rs. 10 levied by Government from the Colonists was not too much?

Mr. Karunaratne: "The levy of Rs. 10 is not per month. Ten rupees is charged per acre, per year, on the cultivated extent of land. I do not think colonists find it difficult to pay this amount. Of course in cases of particularly bad lean years, we hope to recommend to the Minister to waive off the rental."

Mr. Keerthiratne said that before the dry farming programme was implemented in full, it was necessary to ascertain the areas that would be particularly suitable for crops and for stock farming. He inquired whether the Department had carried out investigations to ascertain these areas. He added that in the olden days for stock breeding, people utilised a part of the jungle and went on shifting the area gradually so that after about ten or fifteen years they came back to the same area. He added that the present conditions were quite different to what existed several years back, and that the present day conditions demanded not merely food for the people but also money for their other requirements. Clothing in the Vavuniya District sometime back was only a small piece of span cloth but under modern conditions even the vanni people find it necessary to clothe themselves fully. Therefore he said that it was essential to investigate first, besides their being able to procure their own food, whether the economic conditions of the colonists would be sufficient under modern conditions. It was therefore necessary, he added, to ascertain

whether crop husbandry or animal husbandry would be beneficial to the colonist from an economic point of view. He believed that it was best to encourage the breeding of Scindi animals because the conditions in the dry zone need acclimatised big made animals.

Mr. Keerthiratne also suggested that it was best to have an alternative scheme in case there was a failure of rains for a number of seasons, so that the people could at least take up to animal husbandry.

Referring to the hilly areas of the country which were abandoned, Mr. Keerthiratne inquired whether investigations have been carried out to ascertain if a variety of paddy suitable on hilly land could be found. He said that he knew of a hill paddy called Elwi which thrived well on hill tops. He also inquired whether the Department has been able to recommend to the people varieties of drought resistant crops. Mr. Keerthiratne emphatically stated that it was therefore very essential that the grant of Rs. 6,000,000 from New Zealand should be utilised in the best possible manner so that the country may be benefitted and requested that the grant should not be kept at the disposal of officers who were more inclined to spend the money on their travelling than to achieve something of benefit. He said that the money gifted by that country should be utilised to improve the agriculture and the economic condition of the dry zone peasant "as otherwise those areas would turn out to be the breeding ground of Leftists." He emphasised that as a democratic country, it was the duty of the Government to improve the living conditions of the peasant.

Mr. Keerthiratne referring to the Batticaloa area said that it was once a jungle and the people started growing coconuts. Now the coconuts were dying and the area was turning into a desert. He feared that the same thing would happen to the dry zone too if the problem was not tackled systematically.

He also condemned the practice of clearing jungle of all stumps and using bull-dozers on that land because he believed that the underground root system afforded sufficient means of retaining water and moisture in the soil. In conclusion he stressed the need for conserving underground water courses and building up the water table as practised by cultivators several hundred years back.

Mr. Henry Abeywickrema, M.P., inquired whether it was not a fact that the Government had decided to reduce the unit of acreage assigned to each colonist?

Mr. Karunaratne: "Hitherto the unit has been 5 acres of paddy and 3 acres of highland. That has been regarded excessive and the present proposal is to give 3 acres of paddy land and 1½ acres of highland in irrigation schemes. It cost the Government about Rs. 15,000 to establish a unit. Originally in 1921 when the Kurundankulama scheme was initiated it cost the Government about Rs. 4,000 to establish a unit but now it costs nearly Rs. 13 to 15,000 to establish a unit. The average income a colonist can get from his holding is about Rs. 750 to Rs. 2,000.

Mr. J. M. Sabaratnam: "According to figures it costs Government Rs. 15,000 to establish a unit whereas originally in 1921 when the Kurundankulama Scheme was initiated it cost the Government only about Rs. 4,000. The average income which a person receives from the land ranged from Rs. 270 to Rs. 2,000. The question is whether this could be considered as a reasonable return on an investment of Rs. 15,000 by the State. An average colonist's income if he had been engaged for work on a casual basis would amount to Rs. 900 if he had worked for 300 days per year. In view of this the net return on the investment is only a loss of Rs. 630 up to a profit of Rs. 1,100. The question of continuing this experiment should be therefore considered seriously by Government. Mr. Karunaratne mentioned that in the second experiment he had come across about six tanks in the area that was cleared for dry farming. We would like to know whether that water was used for any kind of irrigation or for purposes of the dry farming scheme. We would also like to know whether the scheme was successful because of the restoration of those tanks and whether the dry faming in that area would have been abandoned if such a water supply was not available? I am aware that dry farming is done in the Vavuniya District on a small scale, say on areas ranging from 2 to 5 acres, but the cultivator earns about Rs. 4,000 or Rs. 5,000 on that holding because a well is available on that land for his use. I think that the grant from New Zealand could be better utilised in finding sources of underground water so that wells could be constructed for Food Production purposes. If wells could be provided and water made available that would be the best attraction for any peasant to take up to cultivation without any further inducement. Recently there was a circular from the Director of Food Production restricting the subsidy for Food Production wells to new lands only. But I know that there are vast extents of previously cultivated land in the Jaffna and Vavuniya Districts which can be cultivated with success. If wells could be constructed and the cultivators are assured of the supply of water."

Mr. Karunaratne: " Regarding the question about the expenditure involved in establishing a unit in these colonization schemes, it costs us approximately Rs. 15,000 to settle a family. This compares very favourably with the irrigation scheme which spends Rs. 15,000 for establishing a unit of 8 acres, whereas we settle a family on 14 acres and the amount we spend is inclusive of the cost of barbed wire.

The second point raised was whether we utilised the water out of the 6 tanks that we came across this area. I have to say that not a drop of water from these tanks was utilised. My intention was not to utilise that water because it was not sufficient to cover more than a few acres. All the highland crops which are unirrigable were cultivated under rain-fed conditions. My idea was to utilise that water in the Yala for vegetable cultivation and to allow the crops to thrive with the October/November rains. But if the crops showed signs of distress towards December, the water could be utilised."

Mr. Sabaratnam: " Is it correct that the income from dry farming is only about 50 per cent. of what could be obtained by paddy cultivation?"

Mr. Karunaratne: " Paddy farming always pays. Originally the idea was to enforce a rotation and compel the colonists to cultivate crops according to the rotation. What we do now is to utilise boggy land for paddy cultivation."

Mr. N. M. Abulcassim Marikar: " I would like to ask a few questions, the first is—to how many districts has this dry farming scheme been extended?

There are a number of ' villus ' (places where there are underground streams) which are eminently suitable for dry farming in the Mannar District. There are a series of ' villus '. In fact it was contemplated a couple of years ago that that area should be ideally suited for dry farming. These ' villus ' are still available for investigation. May I ask whether you have taken into consideration all such places for purposes of your dry farming investigations?"

Mr. Abulcassim Marikar in conclusion said that he was very interested in the finding out of a high yielding strain of seed paddy for the dry zone areas of the Island. He said he was surprised at the headway made by the Department of Agriculture in their different Research Stations established in several parts of the Island. On behalf of the Board, he complimented the officers concerned for their good work and said that he was happy that local talent was available in the direction of research. He added: " The contribution made by the two officers is really interesting, instructive and very useful and I am sure that the progress will be very phenomenal if the services of such Research Officers were available to other parts of the Island too."

Mr. K. Kanagaratnam: " As you are aware, in Jaffna you have no rivers. There are small ponds. As far as my memory goes, for the last 50 years, the Jaffna farmer follows the same procedure. That is, his sowing time is somewhere in August or September and harvests the crop by about February, and then he sows gingelly seed. For this he entirely depends on rain water. If there is no rain, the crops fail. Therefore may I kindly ask whether any experiments had been organised by your Department with regard to Jaffna soils and whether any advice had been tendered to the Jaffna farmer as to how he could improve his methods of cultivation?

The other question is, I am very glad that your Agricultural Officers are carrying out experiments to devise improved implements to suit local conditions. Tractors are being used in the Jaffna District through the help of Co-operative Agricultural Unions. Even on small tracts of land ranging from ¼th to 1/8th acre, these tractors are used for ploughing.

In these two respects I will be very glad to know if any experiments had been hitherto carried out or whether any research will be done in the future so that you will help the poor Jaffna farmer?"

Chairman: " I may say that the Department has left Jaffna to its own resources because we find that in the Jaffna cultivator we have found a man who would deliver the goods in any case. But we realise that it is not entirely correct to leave him alone and I am very pleased to tell Mr. Kanagaratnam that from next month I am appointing a Research Officer to Jaffna for the sole purpose of investigation of dry cultivation in Jaffna. " (Applause.)

Mr. Abulcassim Marikar: " What about the Mannar District, Sir? "

Chairman: "The officer appointed to Jaffna will look after Mannar also. We have six Research Officers, one of whom is for dry farming investigational work at Maha Illuppallama. We have also an officer there who is looking after paddy. We have one in the Eastern Province, one in the Southern Province, one in the Central Province and we are now appointing one to the Northern Province. He will give his attention not only to the Jaffna Peninsula but also to Mannar and Mullaitivu as well.

I must refer to one point. There was the question raised by Mr. Keerthiratne as to how we propose to spend the grant of Rs. 6,000,000 for the dry farming investigations at Maha Illuppallama. The programme and work have been very carefully planned. We have got an Experimental Committee to plan every detail and no expenditure will be incurred until every item is carefully gone into. As a matter of fact, the greater part of the expenditure is to be spent on buildings. About Rs. 4,000,000 will be spent on laboratories, buildings and quarters for officers. One cannot expect officers to go to outlying places like Maha Illuppallama unless quarters are given them. It is absolutely necessary that officers sent to these centres should have at least a modicum of facilities. Maha Illuppallama is not a sanatorium, nor is it a health resort. I would also like to emphasise this point that the money will be spent on research not only on crops, but also on animal husbandry."

Mr. A. M. Clement Dias: "I find we are spending Rs. 15,000 to produce food. If Rs. 15,000 can be spent on three parties to encourage poultry, each will produce 300 to 400 pullets. In 1950 I brought some birds from Europe. About 50 per cent. of them died but I reared the rest and today I am having about 400 birds and I have about 300 pullets." Mr. Dias emphatically stated that if in a place like Holland a hundred-thousand chicks could be produced a week, there was no reason why Ceylon should fail. He therefore suggested that instead of the Government spending Rs. 15,000 on each holding for a colonist, that money be utilised for distribution among three families who should be asked to take up to poultry farming.

Mr. R. T. Chelliah: "Some member in the course of discussion remarked that Jaffna is famous only for onions. I think it is useful to mention for the information of our friends, that Jaffna grows not only onions but even cabbage. Jaffna cultivator is trying to produce even carrots and beet-root and it will be a happy day to see when Jaffna is able to send cabbage, beet-root, &c., to Colombo."

Mr. Chelliah also thanked the Director for his promise of a Research Station at Tinnevelly. Mr. Chelliah mentioned that there were a number of neglected "villus" in Jaffna and if all those "villus" were cultivated, he emphasised, that he could assure the Board that Jaffna could live without coupons.

Mr. Chelliah also paid a compliment on behalf of the Board to Mr. M. Sivanathan, Assistant Director of Agriculture (Administration) and Secretary of the Board for the very efficient manner in which he had handled the work of the Central Board. He added that in his new appointment as A. G. A., Batticaloa, he would be able to make use of the knowledge he had gained in agriculture while being attached to the Agricultural Department. In conclusion he wished him all success in his new appointment, on behalf of the Board.

Mr. S. L. Bandara Dharmakirti stated that he had seen certain newspaper reports that potatoes had been grown very successfully by the Department in farms in the dry zone and whether more information could be had on the subject?

Mr. Karunaratne: "I really do not know how the papers could have reported that potatoe growing was made such a grand success. It was done on a very small scale and the yields were five fold."

Mr. S. M. Rasamanickam, M.P.: "I am very happy to be present here today and to have listened to the addresses of Mr. Abeyratne and Mr. Karunaratne. In fact I have visited Maha Illuppallama Farm myself and I was able to see some of the valuable experiments that are being carried out there. I should say that these Experimental Stations and these experiments on dry farming in this Island are very essential for the agricultural progress of this country. But I am particularly sorry to find that no mention was made as to how it is proposed to extend the scheme of dry farming to other parts of the Island, that is to other dry areas of the Island. In fact I have been interested to know whether this scheme would be extended to the Eastern Province and I have been disappointed.

I would like to make one or two observations in regard to tractor cultivation. Most of the ground has been covered by other speakers and I would like to know whether investigations have been carried out to find out the benefits and defects of tractor cultivation? Tractor cultivation has to be gone into more fully since tractor cultivation has become the policy in the Eastern province. I understand that the full tractor

strength in the Island is about 180, but I find nearly 80 tractors at work in the Eastern Province and most of the ploughing is done by tractors. Therefore what I want is a Research Station to be established in the Eastern Province and that some officer should go into this particular question. The other point I would stress is that these dry farming experiments be extended to other parts of the Island and to Batticaloa itself. Apart from recruiting the usual villagers who have had no knowledge of paddy cultivation, I suggest that young men irrespective of educational qualifications be recruited and sent out to settlements, if not to dry farming schemes, even to colonization schemes, particularly to the Gal Oya valley. I also suggest that the activities of the Karadian Aru Farm School be extended and that a minor Research Station be established at Karadian Aru for small scale investigations, especially on tractor cultivation."

Mr. Karunaratne : "Gentlemen, before we disperse I would like to clear one important conception. Dry farming does not mean raising arable crops only but it is diversified agriculture with livestock woven into the scheme.

In regard to poultry one gentleman said that instead of our spending Rs. 15,000 on settling people, that money could be utilised for promoting poultry development. In that same way, if each colonist is given a pair of bulls, a cow, and 5 hens, the settlement will own about 4,000 pullets in a year.

The other question raised was whether this dry farming scheme was not extended to other parts of the Island. This dry farming scheme is yet in its infancy and in course of time, depending on the results achieved, it is hoped to extend the scheme.

The other point I would like to clear is that irrigated farms should not be mixed up with dry farming. Even if you raise crops with underground resources, it is not dry farming. Then there was a point raised about the limiting of the acreage given under these colonization schemes. An area allotted under an irrigation scheme must be within the capacity of that tank or well. It is useless giving 10 acres of land, if the water available is not sufficient for that extent.

Regarding 'villus' the only difficulty the Irrigation Department had come across was that it had to depend entirely on rain water, so that unless these 'villus' were sufficiently deep, the evaporation rate is high."

Chairman : "Gentlemen, our late Minister of Agriculture, the present Prime Minister instructed that we should first concentrate in these two areas, learn all the difficulties inherent in the successful pursuance of the scheme and then proceed to other areas. In most of our Agricultural Stations there is a certain amount of investigation work carried out on dry farming methods. Even at Karadian Aru we have got a Research Officer stationed and while he concentrates his attention very largely on paddy he has also been asked to do a certain amount of work on dry crops. I thank all the gentlemen who contributed to the discussions on the subject of dry farming. I also thank these two officers (Messrs. C. R. Karunaratne and E. Abeyratne) on behalf of the Board for having given us the benefit of their experience. I think you will agree with me that the procedure adopted by us is very beneficial because you learn all that we have done or are doing on a subject and we learn from you all your experience and difficulties in regard to it."

Date of next Meeting

December 7th was agreed upon as the most convenient date for the next meeting.

Board's appreciation of the Services of the Secretary (Mr. M. Sivanathan, C.C.S.).

Chairman: "Gentlemen, the next point is a matter to which reference has already been made by Mr. Chelliah, that is the impending departure of our Secretary, Mr. Sivanathan, on promotion as A. G. A., Batticaloa. He has been Secretary of the Board for nearly two years and we are very grateful to him that during the time he has been with us he has given of his best and has been extremely helpful to us. Apart from his activities on this Board, I am extremely grateful to him for having given me valuable assistance particularly in the administration of this Department. On behalf of the Board I, therefore, express to him our grateful thanks for all the hard work he has put on matters connected with the Board.

Let me thank him on your behalf and wish him a very successful career. A great and bright future lies ahead of him."

The meeting terminated at 5.30 p.m.

M. SIVANATHAN,
Secretary,
Central Board of Agriculture.

Peradeniya, November 10, 1953.

Tea Research Institute

Minutes of Meeting of the Board of the Tea Research Institute of Ceylon held at the Offices of the Planters' Association of Ceylon, on Friday, October 30, 1953, at 2.30 p.m.

Present.—Mr. R. C. Scott, C.B.E. (Chairman), Messrs. C. Dymoke Green (Chairman, Agency Section, Planters' Association of Ceylon), W. R. Vander Kiste (Chairman, Planters' Association of Ceylon), W. H. Attfield, A. W. R. Joachim, M.B.E., V. G. W. Ratnayake, M.B.E., M.P., G. K. Newton, W. Neal de Alwis, M.P., Errol Jayawickreme, J.P., U.M., D. E. Hettiarachchi, J.P., U.M., A. D. McLeod, B. C. V. Weeks and J. Lamb (Director & Secretary).

1. The Notice convening the meeting was read

Messrs. H. S. Hurst and A. G. Ranasinha had intimated their inability to be present at the meeting.

2. Minutes of Board Meeting held on July 17, 1953

The Minutes of Meeting of the Board held on July 17, 1953, were confirmed subject to the inclusion of Mr. A. D. McLeod's name in the list of those present.

3. Membership of the Board and Committees

(*a*) *Board*

It was reported that:—

(i) Mr. V. G. W. Ratnayake, M.P., M.B.E., had been re-nominated by the Minister of Agriculture and Food as representative of the Small Holders for a further period of three years as from October 15, 1952.

(ii) Mr. H. S. Hurst had been re-nominated by the Planters' Association of Ceylon for a further period of three years as from April 21, 1953.

The Chairman expressed the Board's pleasure at their re-nomination and thanked Mr. B. C. V. Weeks for his services while he had acted for Mr. A. J. Dickson. Mr. Dickson had recently returned to the Island from leave but had not yet resumed his seat on the Board.

(*b*) *Estate and Experimental Sub-Committee*

It was reported that:—

(i) Messrs. S. P. Vythilingam and A. J. Dickson had resumed their seats on the above Committee on their return to the Island from long leave.

4. Minutes of the Meetings of the Estate and Experimental Sub-Committee held on July 11 and October 17, 1953

The Chairman reported that copies of the above minutes had been issued to members. He proposed that the Visiting Agent's report dated July 16, 1953, item 6 (*a*) on the agenda, be taken up for consideration along with the Minutes of the Sub-Committee. It had received the attention of the Sub-Committee at the latter meeting as would be noted from the Minutes.

In reply to a question raised by Mr. W. R. Vander Kiste, the Director (Mr. J. Lamb) gave details of the manna grass experiment which the Committee had agreed to terminate as it had proved unsuccessful.

5. Finance

(i) *Government Loan*

The Chairman informed the members that the final instalment of Rs. 75,315.66 against the Rs. 1,000,000 loan from Government had been paid on September 14. The loan was therefore now fully liquidated.

The Title Deeds of St. Coombs Estate, which have been in Government custody, as security against the loan, have been called for.

(ii) *T. R. I., Cess*

It was reported that receipts from cess for 1953 had, to the end of September, averaged Rs. 70,840 as against Rs. 72,100 for 1952. The total receipt to end of September was Rs. 637,000.

(iii) *Audit 1952 accounts*

The Chairman informed members that the audit of the 1952 accounts which had been delayed on account of Mr. Dias's absence on long medical leave had been completed on October 9. The audit report was now awaited and was expected in good time for the next meeting of the Board.

6. Small Holdings Advisory Service

The Chairman reported that:—

The Minutes of the Meeting of the Small Holdings Sub-Committee held on July 17 had been issued to members.

A further meeting of the Committee was held that morning when among other matters the estimates for 1954 were discussed. These would be circulated to members in time for the next meeting of the Board at which the estimates for 1954 would come up for consideration.

The balance lying to the credit of the Service at the moment was approximately Rs. 80,000. The Committee had recommended that for the time being as much as was considered feasible should be placed in Government Treasury Bills with a view to investment in the Government Loan which was likely to be floated in the near future.

Mr. V. G. W. Ratnayake proposed and Mr. B. C. V. Weeks seconded that the recommendation be implemented. Agreed.

The Director suggested that as the Institute had been making use of the funds, interest at the rate of 2½% should be credited to the Small Holdings Service account. Agreed.

He then gave details of the issues of tea seed and fertilizers during the year by the Service to Small Holders in the various provinces.

	Central Province	*Soutern Province*	*Province of Uva*	*Province of Sabaragamuwa*	*Total*
Tea seed (in maunds) ..	41 ..	28 ..	16½ ..	14 ..	99½
Manure (in tons) ..	105 ..	7·7 ..	9·7 ..	10·6 ..	141

Mr. de Alwis asked that these figures should be circulated amongst all Small Holdings Officers and Instructors.

7. Blister Blight

Contribution from Government.—The Chairman informed that the fourth and final instalment of Rs. 150,000 was received from the Tea Controller on September 5, 1953.

8. Any Other Business

(a) *Guest House Charges.*—The Chairman said that the charges for meals supplied to visitors at the St. Coombs Guest House were based on rates fixed at the inception of the Guest House. It had been pointed out that these rates were now out-of-date and required revision.

It was proposed that the rates be increased as follows:—

Breakfast	....	from Rs. 2/- to Rs. 2/50.
Lunch	... ...	from Rs. 2/50 to Rs. 3/50.
Afternoon tea	....	from Re. 1/- to Re. 1/25.
Dinner	....	from Rs. 2/50 to Rs. 3/50.
Hot Bath	... ...	from 25 cts. to 50 cts.

and that these charges notified in the "Tea Quarterly". Agreed.

(b) *Junior Staff Medical Fund.*—The Chairman informed members that a Memorandum dated October 15 had been received from the Junior Staff Association in which certain submissions had been made regarding medical benefits to the Junior Staff. The matter would be discussed by the Managing Committee of the Junior Staff Medical Fund and their findings put up to the Board for consideration at the next meeting.

Tea Research Institute of Ceylon,
St. Coombs, Talawakelle.

J. LAMB,
Secretary.

Rubber Research Institute

Draft Minutes of the 123rd Meeting of the Rubber Research Board held at the Planters' Association Headquarters, Colombo, at 2.30 p.m. on Monday, October 26, 1953

Present.—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. W. Herbert de Silva, Mr. G. H. Dulling, Mr. R. J. Hartley, Dr. A. W. R. Joachim (Director of Agriculture), Gate Muhandiram Arthur D. S. Jayasinghe, Mr. L. J. de S. Seneviratne (Deputy Secretary to the Treasury), Senator C. F. W. Wickremasinghe, Dr. H. E. Young (Director, R. R. I. C.), and Mr. C. D. de Fonseka (Administrative Secretary).

1. Board

(*a*) *Death of Sir Chales E. Jones, C.M.G.*—Before commencing the business of the day the Chairman referred to the death of Sir Charles E. Jones, C.M.G., who had been a member of the Board some years ago. A vote of condolence was passed in the usual manner.

(*b*) *Senator C. F. W. Wickremasinghe.*—The Chairman reported that Senator C. F. W. Wickremasinghe had returned from leave and resumed membership with effect from 1st October, 1953.

2. Minutes

Draft minutes of the Special Meeting held on August 17 and of the ordinary meeting held on July 6, 1953, which had been circulated to members, were confirmed and signed by the Chairman.

3. Experimental Committee

Recommendations made at meeting of October 3, 1953:

(*a*) *Visiting Agent's Report.*—The following recommendations were approved:—

1. STAFF.—

(i) Appointment of an extra Assistant Clerk to the Estate Office in January, 1954.
(ii) Grant of a special increment to the Conductor-in-charge, Hedigalla Experimental Station.

(*a*) *Research Programme for 1954.*—This was approved and the Committee's recommendations regarding the appointment of additional staff and re-arrangement of existing staff were also approved.

(*b*) *Agency for Production of Local Clones.*—The recommendation that the arrangement whereby proprietary clones such as MK. 3/2, WG. 6278 and the NAB. clones are handled by the Institute on a royalty basis should be terminated was approved.

4. Reports and Accounts

(*a*) *Statement of Receipts and Payments for the Quarter ended June 30, 1953*, was approved.

(*b*) *Draft Estimates for 1954.*—Draft Estimates providing for income and expenditure for 1954 as follows were approved:—

	Rs.	*Rs.*
Estimated Income	..	1,327,446
Estimated Expenditure:		
Revenue	1,261,297	
Capital	572,148	
		1,833,445

Estimated excess of Expenditure over income 505,999.

(*c*) *Supplementary votes.*—Supplementary votes amounting to Rs. 6,231.87 were passed.

5. Staff

(*a*) *Director.*—It was reported that Dr. H. E. Young had returned from leave and resumed duties as Director on September 12. Mr. Van Emden was thanked for his services as Acting Director.

(*b*) *Acting Assistant Mycologist.*—It was reported that Mr. D. M. Fernando, Acting Assistant Mycologist, had returned after completing his course of training at McGill University, Canada, and had resumed duties on September 21, 1953.

(c) *Assistant Staff.*—The following changes in staff were reported:—

1. Appointment of Mr. H. L. Munasinghe as Laboratory Assistant (Myco Dept.) with effect from September 1, 1953.
2. Termination of services of Mr. B. D. de A. Gurusinghe, Rubber Instructor, with effect from September 30, 1953.
3. Transfer of Mr. R. B. Madawala, Rubber Instructor, to the Department of Agriculture for temporary work at its rubber nurseries with effect from August 1, 1953.

6. Contribution to London Advisory Committee and British Rubber Producers' Research Association

The proposed terms of re-organization of the London Advisory Committee and alignment with the B. R. P. R. A. were considered and agreed to.

7. Aerial Spraying of Rubber by Pest Control, Ltd.

Arrangements made in connection with the proposed trial of aerial spraying for Oidium control were reported and it was noted that a grant of Rs. 100,000 had been received from Government for this purpose.

8. London Advisory Committee

The following documents were tabled:—

(a) Annual Report for 1952.

(b) Draft minutes of meetings of the Committee, Technical Sub-Committee and Latex Sub-Committee held on May 6, March 26 and June 29, 1953, respectively.

9. Publications

The following publications were tabled:—

Advisory Circulars No. 37, 38 and 39.
Combined 3rd and 4th Quarterly Circulars for 1952.
Annual Report for 1952.

10. Minister's visit

The Chairman repofted that the Hon'ble Mr. J. R. Jayewardene, Minister of Agriculture and Food, had visited Dartonfield and Hedigalla on October 24 and that he had expressed his pleasure at the work being done by the Institute.

The meeting then terminated with a vote of thanks to the Chair.

Dartonfield,
Agalawatta, January 20, 1954.

Administrative Secretary.

Draft Minutes of the 124th Meeting of the Rubber Research Board held at the Planters' Association Headquarters, Colombo, at 2.30 p.m. on Monday, December 21, 1953

Present.—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. G. H. Dulling, Mr. W. Herbert de Silva, Mr. R. J. Hartley, Gate Muhandiram Arthur D. S. Jayasinghe, Mr. B. Mahadeva (Rubber Controller), Mr. L. J. de S. Seneviratne (Deputy Secretary to the Treasury), Dr. H. E. Young (Director) and Mr. C. D. de Fonseka (Administrative Secretary).

An apology for absence was received from Senator C. F. W. Wickremasinghe.

1. Board

(a) *Mr. E. W. Whitelaw.*—The Chairman referred to the death of Mr. E. W. Whitelaw, who had been a member of the Board for a number of years before his retirement from Ceylon and was at the time of his death the Chairman of the London Advisory Committee for Rubber Research (Ceylon and Malaya).

His death was a great loss to the Board and to the rubber industry in general. A vote of condolence was passed in the usual manner and it was noted that the condolences of the Board and the Staff had already been conveyed to the late Mr. Whitelaw's widow and family through the L. A. C.

(*b*) *Amendment to the Rubber Research Ordinance.*—The Chairman reported that the Ordinance had been amended to provide for inclusion of the Rubber Controller as an ex-officio member of the Board. He welcomed Mr. B. Mahadeva, Rubber Controller, who was present.

2. Minutes

(*a*) *Confirmation.*—Draft minutes of the meeting held on December 21, 1953, which had been circulated to members, were confirmed by the Chairman.

(*b*) *Matters arising from the Minutes.*—

1. *Research Assistant (Bot. Dept.).*—Reported that the Sub-Committee appointed at the last meeting had interviewed candidates for this post and offered the appointment to Mr. L. B. Chandrasekera, B.Sc. (Ceylon), who was expected to assume duties on January 2, 1954.

3. Reports and Accounts

(*a*) *Balance Sheet and Auditor-General's Report for 1952,* were approved.

(*b*) *Re-votes.*—Unspent balances of Capital Votes for 1952 amounting to Rs. 463,008.51 were re-voted for 1953.

(*c*) *Statement of Receipts and Payments for the 3rd Quarter, 1953,* was approved.

4. Staff

(*a*) *Mycologist.*—A letter from Mr. J. H. Van Emden, Mycologist, giving six months' notice of resignation with effect from December 7, 1953, was read.

(*b*) *Assistant Staff.*—

1. *Changes in Staff.*—The appointment of Mr. E. G. Mendis as Laboratory Assistant Myco Dept.), with effect from November 1, 1953, was reported.

2. *Loans for Purchase of Transport.*—Reported that loans of Rs. 1,950 and Rs. 1,500 respectively, had been granted to the Rubber Instructors of Talpe and Talangama for the purchase of motor cycles.

3. *Medical Certificates.*—It was agreed that Medical Certificates from registered and qualified medical practitioners may be accepted to cover sick leave when the officer concerned is too ill to go to a Government Medical Officer for a certificate. This decision is subject to revision later if found necessary.

5. London Advisory Committee

(*a*) *Ceylon Government Representative.*—It was reported that Mr. C. A. Meakin had been appointed as the Ceylon Government Representative on the London Advisory Committee in place of the late Mr. E. W. Whitelaw with effect from January 1, 1954. The Board concurred in this appointment.

(*b*) *Minutes of the 6th Meeting of the Executive Committee held on October 2, 1953,* were tabled.

6. Rubber Conference

Comments from members and others who attended the Conference on November 16 were read and it was noted that the Conference was generally considered to be a success. Possible improvements in arrangements for future Conferences were discussed.

7. Conference of Staff of Research Institutes in the Far East held at Bogor, Indonesia

A copy of the printed report on the proceedings of this Conference was tabled.

The Chairman wished members a happy Christmas and a prosperous New Year.

The meeting terminated with a vote of thanks to the Chair.

Dartonfield,
Agalawatta, January 19, 1954. Administrative Secretary.

NOTIFICATIONS

Milk Board.

L. D—O. 54/49.

AN ACT TO PROVIDE FOR THE CONSTITUTION OF A BOARD TO ESTABLISH AND MAINTAIN FACILITIES AND SERVICES FOR THE EFFICIENT AND CHEAP PRODUCTION AND MARKETING OF MILK, TO PROMOTE THE ESTABLISHMENT AND MAINTENANCE OF SUCH FACILITIES AND SERVICES BY LOCAL AUTHORITIES AND OTHER BODIES AND PERSONS AND TO PROVIDE FOR MATTERS INCIDENTAL TO OR CONNECTED THEREWITH.

BE it enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Senate and the House of Representatives of Ceylon in this present Parliament assembled, and by the authority of the same, as follows:—

Short title and date of operation.

1. This Act may be cited as the Milk Board Act, No. 12 of 1954, and shall come into operation on such date as the Minister may appoint by Order published in the *Gazette*.

PART I.

ESTABLISHMENT OF MILK BOARD.

Establishment of Milk Board.

2. (1) A Board to be called the Milk Board (in this Act referred to as " the Board ") is hereby established for the purposes of this Act.

(2) The Board shall be a body corporate with perpetual succession and a common seal and may sue and be sued in its corporate name.

Common seal of the Board.

3. The common seal of the Board shall be officially and judicially noticed and shall be kept by such person and in such manner as the Board may from time to time determine. The seal shall not be used except by the authority of the Board and in the presence of at least two members thereof who shall sign the document to which the seal is affixed.

Constitution of Board.

4. (1) The Board shall consist of five members appointed by the Minister. The Minister shall appoint one of the members to be the Chairman of the Board.

(2) A person shall be disqualified for appointment as a member of the Board or for continuing as a member of the Board—

(*a*) if he is a Senator or a Member of Parliament; or

(*b*) if he has, directly or indirectly, any interest in a subsisting contract with, or in any work being done for, the Board except as a shareholder (other than a director) in an incorporated company consisting of more than twenty-five members.

(3) Where a member of the Board is a shareholder (other than a director) in an incorporated company referred to in sub-section (2) (*b*) which has entered into any contract with, or is doing any work for, the Board, he shall disclose to the Minister the nature and the extent of the shares held by him in such company.

(4) The Minister may, if he thinks it expedient to do so, remove, by Order published in the *Gazette*, any member of the Board from office without reason stated.

(5) Any member of the Board in respect of whom an Order under sub-section (4) is made by the Minister shall vacate his office on the date of the publication of such Order in the *Gazette*.

(6) Any member of the Board who has been removed from office shall not be eligible for re-appointment as a member of the Board or to serve the Board in any other capacity.

(7) If the Chairman or any member of the Board is temporarily unable to discharge the duties of his office on account of ill-health or absence from Ceylon or for any other cause, the Minister may appoint some other member to act in his place as Chairman or, as the case may be, may appoint some other person to act in his place as a member.

(8) Every member of the Board shall, unless he earlier vacates office by death, resignation or removal, hold office for a period of five years. Any such member who vacates office by effluxion of time shall be eligible for re-appointment.

(9) No act or proceeding of the Board shall be invalid by reason only of the existence of any vacancy among its members or any defect in the appointment of a member thereof.

Remuneration of members of the Board.

5. The members of the Board shall be remunerated in such manner and at such rates as may be determined by rules made under this Act.

Appointment of officers and servants.

6. (1) The Board may appoint such officers and servants as it considers necessary for the efficient discharge of its functions under this Act:

Provided that a person who is not a citizen of Ceylon, according to the law for the time being in force relating to citizenship of Ceylon, shall not be appointed an officer or servant of the Board without the prior sanction of the Minister.

(2) The officers and servants of the Board shall be remunerated in such manner and at such rates, and shall be subject to such conditions of service, as may be determined by rules made under this Act.

(3) The Board may, in accordance with rules made under this Act, establish and regulate a provident fund for the benefit of its officers and servants and make contributions to the fund out of the moneys of the Board.

(4) No person who has directly or indirectly, by himself or his partner or agent, any share or interest in any contract made by or on behalf of the Board shall become or remain an officer or servant of the Board.

Contracts.

7. Contracts on behalf of the Board may be made as follows:—

(*a*) a contract which if made between private persons would be by law required to be in writing, may be made on behalf of the Board in writing under the common seal of the Board;

(*b*) a contract which if made between private persons would be by law required to be in writing signed by the parties to be charged therewith, may be made on behalf of the Board in writing, signed by any person or persons duly authorised thereto by the Board; and

(*c*) a contract which if made between private persons would in law be valid although made by parol only and not reduced into writing, may be made by parol on behalf of the Board by any person duly authorised thereto by the Board.

Delegation of functions and powers of Board.

8. The Board may delegate any of its functions or any of its powers (other than the power to make rules or to appoint officers) to any member or officer of the Board, and may from time to time revoke any such delegation either wholly or in part and either as to persons or purposes; but every such member or officer shall, in the discharge of the functions or exercise of the powers delegated to him, conform to all such directions as are given by the Board. All acts done by any such member or officer, in conformity with such directions and in fulfilment of the purposes or his appointment, but not otherwise shall have the like force and effect as if done by the Board.

PART II.

FUNCTIONS AND POWERS OF THE BOARD.

Functions of the Board.

9. (1) The functions of the Board shall be to establish and maintain efficient and cheap milk production and marketing services, and to promote the establishment and maintenance of such services by local authorities, and by other bodies and persons approved by the Minister, for the purpose of ensuring that an adequate supply of milk of good quality at reasonable prices is available to consumers of milk in Ceylon.

(2) For the purposes of this Act, milk production and marketing services mean facilities and services for the production and marketing of milk, including—

(*a*) dairies and dairy farms;

(*b*) the breeding, sale and purchase of livestock;

(*c*) the purchase, sale and distribution of milk;

(*d*) the grading, packing, storage, adaptation for sale, insurance and advertisement of milk;

(*e*) the purchase, storage, sale and distribution of forage;

(*f*) depots and establishments for the storage, sale, distribution and marketing of milk and forage;

(*g*) the acquisition and maintenance of all such livestock, land, buildings, plant, machinery, vehicles and other equipment as may be necessary for the purposes aforesaid; and

(*h*) all such other matters and things as may be ancillary to the matters or things referred to in the preceding paragraphs.

Power of Board to establish its own departments, etc.

10. The Board may establish its own departments or agencies for the purpose of the discharge of its functions and the exercise of its powers under this Act, or make contracts or other arrangements for such purpose with Government departments, local authorities or any person or body of persons.

Power of Board to sell property.

11. The Board may sell or otherwise dispose of any movable or immovable property belonging to the Board which in its opinion is not required for the proper discharge of its functions.

Assistance to local authorities and other bodies.

12. The Board may, subject to such conditions or restrictions as may be prescribed by rules made under this Act,—

(*a*) grant a loan to any local authority or to any other body or person approved by the Minister for the purpose of assisting such authority, body or person to defray the cost of establishing and maintaining milk production and marketing services;

(*b*) make a grant of money to such authority, body or person for the purpose aforesaid ;

(*c*) sell or let for hire to such authority, body or person any plant, machinery, vehicles and other equipment required for the establishment or maintenance of such services ; and

(*d*) make available, whether for fee or otherwise, to such authority, body or person any milk production and marketing services maintained by the Board.

Power to raise loans.

13. The Board may with the approval of the Minister given with the concurrence of the Minister of Finance, raise loans from the Government or any person or body of persons for the purpose of discharging its functions under this Act.

Power to make rules.

14. (1) The Board may make rules in respect of all or any of the following matters:—

(*a*) any matter which is required to be prescribed;

(*b*) any matter which has to be determined under section 5 or sub-section (2) of section 6;

(*c*) the matters referred to in sub-section (3) of section 6, including in the case of a provident fund the contributions to be made thereto by officers and servants of the Board and the deduction of such contributions from the salaries of such officers and servants;

(*d*) the appointment, promotion, dismissal and disciplinary control of its officers and servants;

(*e*) the meetings of the Board and the quorum for, and the procedure to be followed at, such meetings.

(2) No rule made under sub-section (1) shall have effect until it has been approved by the Minister.

(3) The Minister shall not, without the concurrence of the Minister of Finance, approve of any rule made by the Board in respect of any matter referred to in paragraphs (*b*), (*c*) and (*d*) of sub-section (1).

PART III.

Finance and Accounts.

Fund and General Reserve of the Board.

15. (1) The Board shall have its own Fund and a General Reserve.

(2) All moneys received by the Board, including such sums as may be voted by Parliament for use of the Board, shall be credited to the Fund, and all payments made by the Board shall be made therefrom.

(3) Save as otherwise provided in section 21, the amount standing to the credit of the General Reserve shall not be expended for any purpose except with the prior approval of the Minister.

Accounts of the Board.

16. (1) The Board shall cause its accounts to be kept in such form and in such manner as may be prescribed.

(2) The books of account of the Board shall be kept at the head office of the Board.

(3) The Board shall cause its books to be balanced on the thirty-first day of December in each year and shall, as soon as practicable thereafter, cause to be prepared a profit and loss account and a balance sheet containing a summary of the assets and liabilities of the Board made up to date aforesaid. The profit and loss account and the balance sheet shall be signed by the Accountant and such other officer as may be named by the Board.

Audit.

17. The Board shall have its accounts audited each year by an auditor appointed by the Permanent Secretary. The auditor shall receive such remuneration from the Fund of the Board as the Permanent Secretary may determine.

Auditor's report.

18. (1) The auditor shall examine the accounts of the Board, and ascertain the correctness of the Balance sheet and furnish a report stating—

(*a*) whether he has or has not obtained all the information and explanations required by him; and

(*b*) whether the accounts referred to in the report are properly drawn up so as to exhibit a true and correct view of the Board's affairs.

(2) The report of the auditor shall be transmitted by him to the Board and a copy thereof shall be furnished by him to the Permanent Secretary.

(3) The Board shall, on receipt of the auditor's report in each year, transmit the report, together with the profit and loss account and the balance sheet to which the report relates, to the Minister who shall cause copies thereof to be laid before the Senate and the House of Representatives.

Receipts of Board.

19. A receipt signed by two members of the Board or by an officer expressly authorised by the Board to give receipts shall be an effectual discharge for moneys paid to the Board.

Application of profits.

20. The nett annual profits of the Board for each financial year may be applied to such purposes, including the payment of a bonus to members of the staff of the Board, as may be determined by the Board with the approval of the Minister given with the concurrence of the Minister of Finance; and all sums not so applied for any purpose shall be carried to the General Reserve.

Investment of General Reserve.

21. The amount standing to the credit of the General Reserve may be invested in securities of any description referred to in section 20 of the Trusts Ordinance; and the moneys realised from the sale of any such securities may be re-invested in securities of the like description.

PART IV.

Miscellaneous.

Local authorities.

22. (1) The public services which any local authority is authorised to establish and maintain by or under any written law regulating its powers and duties shall be deemed to include milk production and marketing services; and the provisions of such written law shall be construed accordingly.

(2) The powers vested in any local authority by or under any written law regulating its powers and duties shall be deemed to include the power to make any contracts or other arrangements with the Board for the purpose of establishing and maintaining milk production and marketing services; and the provisions of such written law shall be construed accordingly.

Minister's directions to the Board.

23. In the discharge of its functions and the exercise of its powers the Board shall be subject to, and act in accordance with, such general or special directions as the Minister may issue from time to time.

Interpretation.

24. In this Act unless the context otherwise requires—

" Chairman " means the person appointed by or under this Act to be or to act as the Chairman of the Board;

" local authority " means any Municipal Council, Urban Council, Town Council or Village Committee;

" milk " means the milk of the cow or the buffalo, or any article manufactured or produced from such milk; and

" Permanent Secretary " means the Permanent Secretary to the Ministry in charge of the Minister.

RETURNS

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE ISLAND OF CEYLON—FOR QUARTER ENDING DECEMBER 31, 1953

Province	Disease	Fresh Cases during the Quarter	Total Number from the beginning of this Calendar year to the end of the fourth quarter				Balance ill at end of Quarter
			Cases	Deaths	Shot	Recoveries	
Western Province	Rabies	72	226	—	226	—	—
	Foot-and-mouth	—	2	1	—	1	—
	Tuberculosis	1	1	1	—	—	—
Colombo Municipality	Rabies	19	67	—	67	—	—
	Anthrax	—	1	1	—	—	—
	Tuberculosis	—	1	1	—	—	—
	Piroplasmosis	—	1	—	—	1	—
Quarantine Station	Anthrax	50	86	86	—	—	—
	Pleuro-Pneumonia	—	43	43	—	—	—
Northern Province	Rabies	—	1	—	1	—	—
	Foot-and-mouth	—	648	1	—	647	—
	Anthrax	72	357	357	—	—	—
	Black quarter	—	66	66	—	—	—
North-Central Province	Foot-and-mouth	—	318	3	—	315	—
	Rabies	1	6	—	6	—	—
North-Western Province	Rabies	6	7	—	7	—	—
	Foot-and-mouth	55	116	—	—	116	—
Central Province	Rabies	22	66	—	66	—	—
	Foot-and-mouth	54	271	—	—	271	—
	Anthrax	—	1	1	—	—	—
	Buffalo-pox	—	65	—	—	65	—
Province of Sabaragamuwa ..	Rabies	3	6	—	6	—	—
Province of Uva	Rabies	5	9	—	9	—	—
	Piroplasmosis	1	6	—	—	6	—
Eastern Province	Rabies	—	1	—	1	—	—
	Foot-and-mouth	71	—	—	—	61	10
	Black quarter	16	16	16	—	—	—
Southern Province ..	Rabies	8	19	—	19	—	—

Department of Agriculture,
Peradeniya, Ceylon,
January 22, 1954.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT—SEPTEMBER, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Amparai	93·8	—	73·2	—	80	90	6·7	2·09	6	—
Anuradhapura	91·6	—0·2	74·5	—0·6	64	90	5·6	2·47	5	— 1·29
Badulla	85·7	0	63·9	—0·4	62	94	5·9	1·55	6	— 2·94
Batticaloa	89·9	+0·1	75·4	—0·8	73	88	4·4	2·40	3	+ 0·01
Colombo	85·4	0	77·1	+0·4	74	82	6·4	3·51	15	— 3·33
Diyatalawa	77·2	—0·6	59·9	—1·0	69	89	5·6	2·56	9	— 1·85
Galle	82·8	—0·1	77·7	—1·9	80	84	5·8	4·12	24	— 4·69
Hambantota	87·3	+0·7	76·6	+0·4	76	88	5·4	0·90	5	— 1·86
Jaffna	86·6	+0·3	80·0	+0·7	76	82	6·8	1·13	3	— 1·40
Kankesanturai	89·9	—	79·6	—	70	85	5·9	1·37	3	—
Kandy	82·7	—	68·3	—	70	90	5·9	2·74	12	—
Kurunegala	87·4	—0·2	74·6	+0·3	66	84	6·0	4·90	12	— 0·65
Maha Illuppallama ..	90·4	—	74·2	—	64	88	6 0	3·10	6	—
Mannar	88·0	+0·3	79·7	+0·9	78	87	6·4	2·26	2	+ 1·02
Nuwara Eliya	66·7	—0·1	54·1	+1·0	81	85	6·6	6·53	19	— 1·71
Puttalam	88·1	+1·3	77·8	—0·1	70	86	5·8	1·82	4	+ 0·24
Ratnapura	88·0	+0·8	73·2	—0·3	72	93	5·7	11·54	22	— 2·98
Ratmalana	86·1	—	78·5	—	71	80	6·3	3·34	16	— 3·34
Trincomalee	91·9	—0·2	76·9	—0·2	64	79	6·6	3·45	8	+ 0·02
Talawakele	72·1	—0·2	58·4	+0 1	85	94	6·5	8·12	22	— 1·63

WEATHER SUMMARY—SEPTEMBER, 1953

IN September again the rianfall was appreciably below normal in the south-western parts, the greater deficits, of the order of 5 to 10 inches or more, occurring scattered over this area. The greatest deficits were 13.41 inches at Theydon Bois Group, 10.58 inches at Hapugastenne Estate and 9.60 inches at Maliboda Estate. Outside the south-west quarter, the rainfall was above normal in places, the biggest excesses being only 4.50 inches at Alupolla Group and 3.44 inches at Stratheden Estate.

The greater monthly totals (those over 15 inches) occurred on the south-western slopes of the hills, where Norton Bridge recorded 21.30 inches for the month, Wewelta1awa Estate 19.50 inches, Padupola 19.23 inches and Alupolla Group 19.03 inches. Outside this area the rainfall decreased gradually, monthly totals at the coastal stations being less than 5 inches. In the north and the east, the rainfall ranged generally from 2 to 5 inches, with smaller amounts here and there.

The weather during the month was mainly monsoonal, rainfall being confined chiefly to the south-western parts. During the period, 9th to 11th, on account of a trough of low pressure, fairly widespread rain was experienced, the rainfall being heaviest on the 10th, a number of stations in the south-western hill-country recording over 3 inches. At 9 stations the falls exceeded 5 inches, the highest being 7.02 inches at Norton Bridge and 6.83 inches at Arslena Estate. Many stations in the north and the east received rain only during this period. Some scattered evening thundershowers were experienced on the 16th and 17th.

Day temperatures were, on the whole, about normal, while night temperatures were above normal in the west and below normal in the east. The highest temperature recorded during the month was 96.2° at Batticaloa on the 4th, and the lowest temperature, 69.7° at Ratnapura on the 29th (for the low country)

and 47.3° at Nuwara Eliya on the 19th (for the whole Island). Humidity ranged generally from 65 to 80% by day and from 80 to 95% by night. Cloud amounts were above average and wind strength about average, the prevailing direction of wind being south-westerly.

D. T. E. DASSANAYAKE,
Director.

METEOROLOGICAL REPORT—OCTOBER, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Amparai	89·9	—	73·7	—	—	93	7·3	7·78	21	—
Anuradhapura	88·5	—0·4	73·6	+0·1	78	93	7·0	17·35	21	+ 7·63
Badulla	81·9	—0·9	66·7	+1·2	78	95	6·8	12·52	25	+ 3·63
Batticaloa	85·8	—1·3	75·0	—0·3	80	95	5·7	7·87	23	+ 0·68
Colombo	84·9	—0·1	74·7	—0·1	77	88	7·1	25·62	27	+11·91
Diyatalawa	76·6	+0·3	60·9	+0·4	80	97	6·8	13·83	22	+ 4·65
Galle	82·8	—0·2	75·6	+0·2	81	88	6·6	18 83	29	+ 6·78
Hambantota	86·4	+0·2	75·6	+0·3	81	91	4·9	6·84	19	+ 2·08
Jaffna	85·6	—0·2	78·4	+0·8	82	89	6·6	10·53	17	+ 1·33
Kankesanturai	85·8	—	77·4	—	80	91	6·8	12·62	18	—
Kandy	83·6	—	68·6	—	75	92	6·8	17·86	23	—
Kurunegala	86·7	—0·6	73·4	+0·2	74	88	6·4	18·59	28	+ 3·73
Maha Illuppallama ..	87·8	—	73·4	—	74	93	6·9	15·76	20	—
Mannar	86·3	—0·6	77·9	+0·6	81	89	7·4	11·56	20	+ 4·98
Nuwara Eliya	68·8	+1·2	54·3	+2·4	84	91	6·9	7·17	26	— 2·59
Puttalam	86·4	+0·2	75·4	—0·2	78	93	6·8	10·96	23	+ 3·53
Ratnapura	87·7	+0·6	72·9	+0·1	80	93	6·6	27·77	27	+ 9·76
Ratmalana	85·6	—	76·3	—	75	86	6·7	19·65	26	+ 6·45
Trincomalee	87·2	—0·8	75·8	—0·2	77	88	6·9	8·10	23	— 1·45
Talawakele	73·4	+0·1	58·4	+0·7	86	97	6·2	10·29	26	+ 0·23

WEATHER SUMMARY—OCTOBER, 1953

THE weather during October was typical of the month. At the beginning there were evening thundershowers. From about the 3rd, on account of disturbances in the Arabian Sea and the Bay of Bengal, rainfall was experienced frequently, with cloudy skies and occasional thunder. The rainfall was heaviest in the south-western mid-country, where some stations experienced rain almost daily, with considerably heavy falls on the 9th, 20th and 25th. On the 25th there were about 40 daily falls exceeding 5 inches. These heavy rains resulted in local floods in the Western and North-Western Provinces. The wind was generally light. But, on a few days between the 19th and 30th, strong gusts were experienced during rainsqualls.

The greatest monthly totals were recorded at Gonapenigala Estate and Weweltalawa Estate with 53.30 and 41.51 inches respectively, while other stations with totals exceeding 35 inches were Halwatura Estate 39.61 inches, Pimbura 36.43 inches and Kumbaduwa Estate 35.17 inches. In the south-western low-country and in the southern parts of Kurunegala District the monthly totals exceeded 20 inches. There was a gradual decrease in rainfall towards the north and the east, the lowest totals (5-10 inches) occurring in parts of the Northern and Eastern Provinces and in the immediate lee of the hills.

The rainfall was above normal over a large portion of the Island, the excesses in the south-western mid-country being considerably high. The greatest excesses were 31.68 inches at Gonapenigala Estate

19.23 inches at Halwatura Estate, 18.97 inches at Newfoundland Estate and 18.90 inches at Kokkawita Group. There were comparatively high excesses (above 10 inches) in Kurunegala District, too. Deficits generally small, occurred among the central hills and in the northern parts to north of Trincomalee-Mannar, the biggest deficits being 10.44 inches at Hapugastenne Estate and 6.74 inches at Mullaittivu.

The number of daily falls over 5 inches exceeded 90, most of them occurring on the 9th, 20th or 25th. The highest were 11.10 inches at Gonapenigala Estate and 8.76 inches at Newfoundland Estate on the 25th.

Day temperatures were irregularly distributed on both sides of average, while night temperatures were mostly above average. The highest temperature recorded was 96.2° at Anuradhapura on the 2nd, and the lowest temperature, 70.4° at Maha Illuppallama on the 31st for the low-country, and 48.1° at Nuwara Eliya on the 9th for the whole Island. Humidity varied from 75 to 85%, by day and from 85 to 95%, by night. Skies were distinctly more cloudy. Winds were slightly below the average strength, the predominent direction being south-westerly.

D. T. E. DASSANAYAKE,
Director.

METEOROLOGICAL REPORT, NOVEMBER, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Anuradhapura	86·5	+0·7	69·4	—2·2	73	95	5·0	5·55	16	— 5·12
Badulla	79·6	+0·3	63·9	—1·6	73	94	5·8	9·11	12	— 1·14
Batticaloa	84·7	+0·5	73·0	—1·3	78	95	4·1	9·23	16	— 4·63
Colombo	85·7	+0·4	72·0	—1·4	69	85	3·8	15·08	12	+ 1·99
Diyatalawa	75·8	+1·7	58·1	—1·8	78	94	5·8	7·76	15	— 2·66
Galle	84·7	+1·1	73·4	—0·9	73	88	4·2	5·95	13	— 6·06
Hambantota	85·7	+0·3	73·5	—0·5	77	90	4·8	9·79	10	+ 2·22
Jaffna	85·2	+1·1	74·4	-0·4	73	86	6·2	10·37	15	— 6·90
Kankesanturai	84·3	—	75·4	—	76	84	5·9	13·86	16	—
Kandy	83·6	—	66·1	—	69	92	4·2	7·53	14	—
Kurunegala	87·2	+0·2	70·6	-1·3	66	90	4·6	5·02	10	— 7·37
Maha Illuppallama ..	85·6	—	70·1	—	73	93	5·6	6·97	14	—
Mannar	84·6	0	75·2	—0·4	74	86	6·0	7·63	12	— 2·56
Nuwara Eliya	70·0	+2·3	49·9	—1·3	74	84	4·6	6·16	10	— 3·03
Puttalam	86·5	+0·9	71·8	—1·4	72	93	4·4	5·44	14	— 4·69
Ratnapura	89·8	+2·2	70·9	—1·4	70	93	4·6	10·27	13	— 4·52
Ratmalana	87·3	—	74·2	—	64	84	4·2	12·37	13	+ 0·25
Talawakele	74·5	+1·0	55·3	—1·9	74	91	3·8	5·38	11	— 3·12
Trincomalee	83·6	0	74·7	—0·1	75	86	5·7	8·07	14	— 5·87

WEATHER SUMMARY—NOVEMBER, 1953

UNSETTLED weather in the Bay of Bengal was responsible for a week of settled weather over Ceylon during last month (3rd to 9th), with dry winds, no rain and cold nights. This is an unusual occurrence for November which is normally the rainiest month of the year. However, the cyclonic movement in the Bay of Bengal was so situated that, near Ceylon, winds were north-westerly, and on account of their previous passage over the arid plains of South India, they were devoid of moisture. Consequently, skies were clear and no rain was experienced over the whole Island, while nights were unusually cold with minimum

temperatures several degrees below average. A similar period of dry weather with cold nights occurred again between the 19th and 22nd.

From about the 13th north-east monsoon conditions were in evidence for a few days, when monsoon rain was experienced in the north and the east and evening thundershowers elsewhere. Rainfall was moderately heavy on the 13th, 14th, 16th and 17th. Fairly heavy widespread rain was experienced on the 28th too.

Over a major part of the Island monthly rainfall ranged from 5 to 10 inches only. Larger totals (10 to 15 inches or more) were found in the south-western low-country, among the eastern and south-eastern hills and in Jaffna District, the highest being 24.38 inches at Hendon Estate, 23.81 inches at Forest Hill Estate, 22.68 inches at St. Martin's (Upper) Estate and 22.13 inches at Udahena Estate.

Rainfall was below normal over most of the Island, bigger deficits (of the order of 5 to 10 inches) occurring on the south-western slopes of the hills and adjacent mid-country and in the north-eastern low-country. The biggest deficits were 12.85 inches at Aramayaka, 12.43 inches at Mayfair Estate, 12.4 inches at Polgahawela and 11.45 inches at Nedunkeni. Excesses, generally small, occurred scattered in places, mainly in the south-eastern parts, the only appreciable ones being 6.17 inches at Hambegamuwa and 5.20 inches at Tissamaharama.

There were 23 daily falls over 5 inches, most of which occurred between the 27th and 29th. The highest was 9.23 inches at Mawarella Estate on the 27th.

Temperatures were well above normal by day and well below normal by night. The highest temperature recorded was 92.9° at Ratnapura on the 11th and 27th, and the lowest, 60.4° at Anuradhapura on the 22nd for the low-country, and 37.3° at Nuwara Eliya on the 23rd for the whole Island. Humidity ranged generally from 65 to 75% by day and from 85 to 95% by night. Cloud amounts were below average. Winds were of average strength, the direction being variable.

D. T. E. Dassanayake,
Director.

METEOROLOGICAL REPORT, DECEMBER, 1953

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		in.		in.
Anuradhapura	84·3	+1·1	69·2	—0·9	76	95	4·4	8·22	12	+ 0·70
Badulla	76·0	—0·6	65·1	+0·6	84	95	7·2	14·09	23	+ 2·86
Batticaloa	82·2	+0·3	73·4	—0·2	83	95	5·2	18·55	21	+ 1·56
Colombo	86·6	+1·1	72·6	+0·2	68	83	4·0	4·69	7	— 0·92
Diyatalawa	72·3	+0·3	59·2	+0·6	87	97	6·8	9·10	25	+ 1·03
Galle	84·1	+0·5	73·7	+0·3	77	90	4·8	10·05	15	+ 2·23
Hambantota	86·0	+1·4	73·7	+0·7	77	90	4·8	0·84	9	— 4·77
Jaffna	82·7	+0·2	74·0	+1·0	74	86	5·2	4·64	10	— 5·75
Kankesanturai	82·4	—	75·4	—	78	84	4·9	6·39	12	—
Kandy	82·3	—	66·0	—	71	89	4·6	4·54	15	—
Kurunegala	85·9	+0·1	70·4	—0·4	65	87	4·0	1·87	11	— 4·91
Maha Illuppallama ..	83·8	—	69·8	—	77	93	4·8	9·16	16	—
Mannar	82·9	+0·1	75·4	+0·6	76	84	4·8	4·33	13	— 3·46
Nuwara Eliya	69·2	+1·5	50·1	+1·2	82	90	5·2	6·44	15	— 1·37
Puttalam	85·6	+0·9	71·2	0	75	93	4·4	4·91	15	— 0·64
Ratnapura	89·1	+1·1	71·7	0	74	93	5·6	7·63	14	— 1·49
Ratmalana	87·8	—	73·7	—	67	86	4·2	7·59	6	+ 0·94
Talawakele	74·0	—0·4	57·1	—1·1	76	88	3·8	5·29	13	+ 0·11
Trincomalee	80·9	—0·2	76·0	+1·2	81	86	5·8	8·49	18	— 4·51

WEATHER SUMMARY—DECEMBER, 1953

THE rainfall in December was irregularly distributed on both sides of average, deficits predominating. The greater deficits (of the order of 5 to 10 inches) occurred in the Northern Province and in limited areas to north-west of the central hills, while the greater excesses (also of the order of 5 to 10 inches) occurred in the north-eastern hill country and to south of the hills. The greatest deficits were 11.76 inches at Nedunkeni, 8.86 inches at Jaffna Farm School and 7.97 inches at Rotawewa, and the greatest excesses 14.88 inches at Iddumekelle Estate, 12.68 inches at Keenakele Estate and 9.41 inches at Mawarella Estate.

Rainfall was heaviest on the north-eastern slopes of the hills, where several stations recorded totals over 25 inches, the highest being 43.31 inches at St. Martin's (Upper) Estate, 40.20 inches at Iddumekelle Estate, 39.97 inches at St. Martin's (Lower) Estate and 38.86 inches at Keenakele Estate. In the north-eastern low-country and over a major part of the south-western low and mid-country the monthly totals ranged from 10 to 20 inches. The rainfall was least in the neighbourhood of Kurunegala-Negombo, where the monthly totals were below 2 inches.

The weather during the month was generally of the north-east monsoon type. But the rainfall was mainly confined to the north-eastern hill country and the neighbouring low-country, so that the northern parts to north of Trincomalee received less than half the average for the month. The weather was slightly unsettled on a few days, viz.:—13th, 24th and 25th, on account of low pressure, when fairly heavy widespread rain was experienced. Dry weather prevailed during the period, 3rd to 8th, and on the 17th and 22nd.

There were 12 daily falls over five inches, the highest being 7.83 inches at Vaganeri on the 26th.

Temperatures were appreciably above normal, particularly by day. The highest temperature recorded was 92.0° at Ratnapura on the 2nd, and the lowest temperature, for the low-country 59.8° at Anuradhapura on the 4th, and for the whole Island 34.3° at Nuwara Eliya on the 8th and 23rd. Day humidity varied from 80 to 85% in the east, and from 65 to 75% in the west. Night humidity ranged generally from 85 to 95%. Cloud amounts were a little above normal. Wind strength was also a little above normal, the predominant direction being north-easterly.

D. T. E. Dassanayake,
Director.

LIST OF NEW BOOKS ACQUIRED BY THE LIBRARY, DEPARTMENT OF AGRICULTURE, PERADENIYA

1. Good Land from Poor Soil—*E. R. Hewitt.*
2. How to Increase Plants—*A. C. Hottes.*
3. The Better Utilization of Milk—*R. C. Hutchinson.*
4. General Field Crops Laboratory Manual—*Leonard & Wood*, 3rd Edition.
5. Tree Crops—*J. R. Smith.*
6. Veterinary Pathology and Bacteriology—*Gaiger & Davies*, 3rd Edition.
7. Wild Animals in Captivity—*H. Hediger.* (Permanent issue to Veterinary Laboratory).
8. Genetics in the Twentieth Century—*L. C. Dunn.*
9. Aids to Histology—*G. H. Bourne*, 5th Edition. (Permanent issue to V. R. O.).
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11. Veterinary Obstetrics—*Benesch & Wright.* (Permanent issue to V. R. O.).
12. Practical Veterinary Pharmacology, Materia Medica and Therapeutics—*H. J. Milks*, 6th Edition. (Permanent issue to Veterinary Research Officer).
13. Market Gardening—*R. A. Robinson.*
14. Elementary Surveying—*J. Malcolm.*
15. The Methods of Statistics—*L. H. C. Tippett*, 4th Edition.
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17. Dairy Enterprises—*Field & McDowell*, Revised Edition.
18. Soil Science, its Principles and Practice—*W. W. Weir*, 2nd Edition.
19. Feeds and Feeding, Abridged—*F. B. Morrison*, 8th Edition.
20. Conserving Soil Resources—*Chapman, Fitch et al.* (Permanent issue to S. C. O.).
21. The Economic Development of Ceylon, Parts I & II (World Bank Report).
22. Sand and Water Culture Methods Used in the Study of Plant Nutrition—*E. J. Hewitt.*
23. The Diagnosis of Mineral Deficiencies in Plants—*T. Wallace*, 2nd Edition. (Permanent issue to School of Agriculture).
24. Hymenoptera of America North of Mexico—*Mucsebeck, Krombein et al.* (Permanent issue to School of Agriculture).
25. The Garden in the Plains—*A. W. Harler.*
26. Everyday Gardening in India—*E. W. Grindal.*
27. Patterns of Mammalian Reproduction—*S. A. Asdell.* (Permanent issue to S. A. H. (D)).
28. Hen Batteries—*W. P. Blount.* (Permanent issue to S. A. H. (D)).
29. Bovine Tuberculosis—*J. Francis.* (Permanent issue to S. A. H. (D)).
30. The Principles and Practice of Feeding Farm Animals—*Halnan & Garner*, 3rd Edition. (Permanent issue to S. A. H. (D)).
31. Veterinary Materia Medica and Therapeutics—*Hoare*, 6th Edition. (Issued to S. A. H. (D)).
32. Handbook of Medical Protozoology—*C. A. Hoare.* (Permanent issue to S. A. H. (D)).
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37. Clinical Diagnosis of the Internal Diseases of Domestic Animals—*B. Malkmus*, 11th Edition. (Permanent issue to S. A. H. (D)).

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75. Report to the Ontario Legislature from the Select Committee on Conservation. (Permanent issue to Soil Conservation Officer).

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